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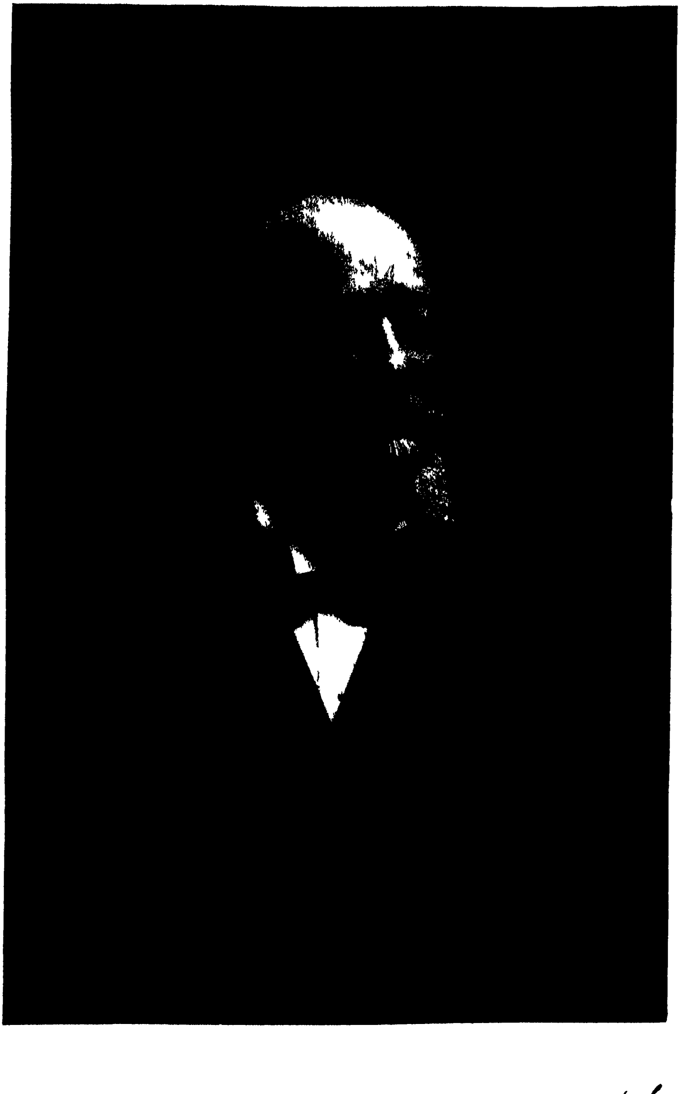

Professor A. Railliet

UNDULANT FEVER IN THE GOAT IN MALTA

BY

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(Received for publication 17 October, 1921)

PLATES I AND II

Undulant fever, which, notwithstanding the decisions of International Boards, is still by many called Mediterranean fever or Malta fever, is, as heretofore, a disease which causes much suffering and anxiety.

Since the year 1905, when it was demonstrated that the infection was caused by the drinking of milk, more especially that of goats, the Public Health Department of Malta has been endeavouring not only to minimise the occurrence of the disease, but to find a way to stamp it out. For this purpose it has been instructing the public as to the prophylactic measures it should follow, and at the same time keeping watch over the milch animals on the Islands.

In the ten years (1894-1903) preceding the appointment in 1904 of the Mediterranean Fever Commission, the average number of cases in the Maltese Islands was Malta 3·2, Gozo 1·9 per 1,000 of estimated mean population per annum.

During the years 1901, 1902 and 1903, among the ships of the British Mediterranean Squadron constantly at Malta, with an average crew of 8,230, there was an average of 28·55 cases per 1,000; whereas from 1897 to 1903, amongst the British Garrison on the Islands, there was an average of 25·6 cases per 1,000 per annum.

The apparently greater rate of infection among the Services, as compared with that of the civil population, may be explained by the fact that in the Services every case of illness comes under the notice of the Medical authorities, whereas in the civil population slight cases pass unnoticed, and other, possibly numerous cases, are either incorrectly reported or are not reported at all. This happened more especially before 1904, when, owing to insufficient knowledge, the fever was incorrectly diagnosed, and sufficient importance was not given to it.

When it was found out that the fever resulted from the drinking of goat's milk, and that the micro-organism causing the infection could be destroyed at a temperature below 100° C., the Maltese Sanitary Authorities at once made it known that the heating to boiling point of fresh milk would free it from infection.

The Naval and Military Authorities were also prompt to take action. Thus in June, 1906, goat's milk was banished from the dietary of the Garrison (*A.M.D. Report* for 1906, Vol. XLVIII, p. 78), while the C.-in-C.'s General Order to the Fleet, dated 4th August, 1906, prohibited the use of unboiled milk (*Navy (Health) Statistical Report* for 1906, p. 119). By these means a disease, the etiology of which had not only baffled the skill of medical men for about a century, but had also affected the efficiency of the Mediterranean Fleet and the Malta Garrison, was arrested; probably a unique case in medical history. The use of fresh milk had no sooner been tabooed in the Services than the number of cases of undulant fever dropped as if by magic, and both the Navy and the Army on this station have since been almost entirely free from it. English people, whose duty compelled them to reside in Malta for some time, obtained a like relief by adopting the simple precaution of boiling the fresh milk or abstaining from it.

Before 1904, few of the employees of the Electric Telegraph Company, the dockyard, etc., or their families, escaped infection; but it is now an exception for a foreign resident, who takes the necessary precautions, to fall a victim to undulant fever. The bulk of the Maltese population, who thought they knew better, have not heeded the caution repeatedly given out by the Sanitary Office as to the danger of using unboiled milk, with the result that there has been hardly any decrease in the number of cases of undulant fever.

THE GOATS

'The Maltese goat is the hardiest, the tamest, the best milking goat in existence. It bears a resemblance to the Theban or Egyptian goat, from which it probably originated. Like the Theban goat, it is generally beardless and frequently hornless, has spreading and slightly pendulous ears, though shorter and narrower, has a convex profile though not so marked as in the Theban goat,

has very often a pair of lappets on the throat, and like it is often of a reddish colour, but it has larger hair and the udders are very large, in relation to its remarkable milking qualities. Maltese goats milking at the rate of $5\frac{1}{2}$ litres (about $9\frac{1}{2}$ pints) in twenty-four hours are not uncommon. White haired goats were formerly preferred by goatmen, but it was found that they are less hardy than the reddish or black-haired ones.' (Dr. J. Borg, in 'Malta and Gibraltar,' compiled by Allister Macmillan, p. 237, London, 1915.)

From time immemorial, goats in Malta have been milked at people's doors, and it is impossible by legislation to compel householders to boil their milk, but it has been made unlawful for hotels, restaurants, coffee-houses, etc., to serve other than boiled milk. Such a measure should have helped to educate the people in the matter, but the general public has yet to be convinced that an apparently normal beverage drawn straight from the familiar goat can be productive of a deadly fever.

One must also bear in mind that the conclusions of the Commission have not remained unchallenged; apologists have come forward offering negative evidence in defence of the offending goat. Others, who could see only the financial side of the question, have pleaded the cause of the poor milkman.

The Sanitary Authorities, seeing how their efforts were being thwarted, devised other means to protect the sceptical public. Periodical inspection of goats by trained sanitary officers was instituted, and samples of milk, or blood, were taken. The Widal and the Zammit* tests are applied to the blood or milk respectively on the day of their collection. If the goat is found to react it is sent to the Lazaretto under escort, and is there examined by a veterinary surgeon, who assesses its value as a dry goat. The

* *Widal reaction.* Dilutions of the serum of 1 in 80 and 1 in 100 are made with salt solution. The emulsion of *M. melitensis* consists of one to which formalin has been added. One drop of the emulsion and 1 drop of the diluted serum are mixed. The mixture is placed on one of the ½-inch spaces ruled with a diamond on a glass slide about a foot long. The slide is rocked to and fro for about a minute and placed in a wet chamber at room temperature. Results are read after about two hours, but the reaction is usually obtained, in a positive case, after one minute's rocking of the slide. Naked-eye appearance is sufficient, though a hand lens is sometimes used. In this way about 100 specimens of blood can be examined in a day.

Zammit reaction for milk. Loopfuls of diluted milk and emulsion of culture are mixed on a slide so as to give resulting dilutions of 1 in 20 or 1 in 40. The mixture is drawn into a capillary tube, which is sealed at both ends and stood on end in sand. The result is read next day, though the reaction is sufficiently clear in a couple of hours, the naked-eye appearance of the precipitate being quite characteristic. In doubtful cases the previous test is applied.

owner has the right of appeal on the question of value. The goat is slaughtered at the Lazaretto. The average annual amount paid as compensation to owners for the destruction of infected goats is about £500. In the estimates for 1921 the sum of £700 is allocated. The average cost of an infected goat in pre-war time was 20s.

It was primarily intended to inspect the twenty thousand odd goats spread over the two islands twice yearly; but the limited special staff available could not cope with the work, and the inspection of goats, sheep and cows is consequently restricted. As the inspections are made periodically only, animals that become infected in the interval remain undetected for some time, and consequently a number of infected goats always exist; hence it is not surprising that undulant fever is still prevalent among the civil population.

The systematic, but limited purification of the herds effectually reduced the disease among the animals, and although the frequent examination of every milch animal, with the consequent slaughter of those found infected, is costly, it should be made continuous if the fever is to be eliminated. A much larger staff should be organised; that available has been unable to inspect yearly more than about six thousand, out of about twenty thousand goats.

According to the reports of the Public Health Department, the number of goats examined and the rate of infection found were as follows:—

TABLE I

Showing the rate of infection with *M. melitensis* of goats in Malta

Year	No. of goats examined	No. infected	Percentage
1907-08	1,203	170	14·1
1908-09	1,099	32	2·9
1909-10	9,924	461	4·6
1910-11	13,372	402	3·0
1911-12	13,756	386	2·8
1912-13	11,453	414	3·6
1913-14	6,896	381	5·9
1914-15	4,965	385	7·7
1915-16	6,630	598	9·0
1916-17	7,768	536	6·9
1917-18	5,921	287	4·8
1918-19	4,613	187	4·0
1919-20	5,690	341	5·9

The infection rate is consequently about 5 per cent., a dangerous percentage, for a single goat may infect hundreds of persons during its milking activity.

Sheep are less liable to infection than goats, probably owing to the smaller size of their udders with a consequent smaller chance of abrasion, but there are no reliable statistics as to the number of sheep infected.

In the light of modern treatment of infective diseases, prophylactic inoculations with a *melitensis* vaccine have been suggested on various occasions. In 1906, Dr. Eyre, one of the members of the Mediterranean Fever Commission, used a vaccine in fifty-one cases; of these, twenty-two received one injection and twenty-nine received two injections of 200-400 million cocci. Two of the cases vaccinated contracted the disease.

Professor M. H. Vincent (1918), of Paris, carried out vaccination experiments on goats and published his results in a paper, in which he claimed to have solved the problem of the *melitensis* infection.

The Maltese Government, wishing to utilize Professor Vincent's vaccine, asked the writer to report on the matter. It was agreed, therefore, to repeat Vincent's experiments as described by him, on a number of local goats. The writer, who was no longer in a position to conduct the experiments himself, had the honour to be entrusted with their supervision.

The Technical staff of the Public Health Department carried out the experiments in a most conscientious manner. They all had long experience, both with the micro-organism and with infected goats, and followed Vincent's directions in all particulars. A full report of the work will eventually be published, so that I will only mention the broad conclusion arrived at, that is, that the bright hopes built on the French savant's paper have been dashed to the ground. The immunisation of the vaccinated animals did not occur, and a minimal dose of virulent culture of *M. melitensis* infected both the experimental animals and the controls.

The question remains therefore, *in statu quo*, and either another vaccine will have to be devised or vigorous direct action be taken to free the island from the fever.

At this point, one cannot allow to go unchallenged an assertion that Professor Vincent made in the above-mentioned paper to the

effect 'that an infected goat recovers spontaneously after a period of time more or less long.' This is a bold assertion, which is intimately connected with the whole prophylactic question of the fever. I do not believe that Professor Vincent is justified in making such an assertion, which is contrary to our experience.

The writer who has a very long experience of goats, both normal and infected with *M. melitensis*, has never known an infected goat to recover. The animal may feed well and look bright, its blood may completely lose its agglutinating power, but a careful post-mortem examination shows, as a rule, the micrococcus lurking in one or another of the glands.

After kidding, a goat, that has for about two years appeared healthy and free from an infection it had previously contracted, yields a milk teeming with *melitensis*.

It is satisfactory to read in the Chief Government Medical Officer's Report for 1918-19, that 'the notified number of cases (three hundred and sixty-three) points again this year to diminished incidence of the disease, with deaths—sixteen—representing a *case mortality* of only 4·4 per cent. This is the smallest on record, and is equal only to a death rate of 7·1 per 100,000.' In the report of 1919-20, however, the disease shows a slight recrudescence (six hundred and nineteen cases with a case mortality of 5·1 per cent.), which reduces the hope for a progressive amelioration.

The civil population, too, can protect itself, by using no milk that is not previously boiled. Were this simple procedure to be strictly followed, the fever would disappear from the civil population as it did from the Navy and Army. As, however, most of the people remain obdurate, or careless, it is our duty to eradicate the disease by vigorously acting against the main cause: by destroying every animal found to be infected.

Goats are not susceptible to a cure, and even were a cure possible, their treatment would, in the happiest event, be long and costly; more costly than the animal itself.

An adequate inspection staff should be provided, and no expense spared. Were this done, I am confident that the fever would disappear from the island in a short time.

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EXPLANATION OF PLATE I

Fig. 1. Maltese Goat, presented to the Museum of the Liverpool School of Tropical Medicine by Prof. T. Zammit. Photo by Miss M. Brown.

Fig. 2. Group of goats, Malta.

Fig. 3. Maltese Goat, presented to the Museum of the Liverpool School of Tropical Medicine by Prof. T. Zammit. Photo by Miss M. Brown.

FIG. 1

FIG. 2

FIG. 3

C. Tinling & Co., Ltd., Imp.

EXPLANATION OF PLATE II

Fig. 1. A milch goat, Malta.

Fig. 2. Group of goats, Malta.

Fig. 3. A milch goat, Malta.

Fig. 1

Fig. 2

Fig. 3

C. Tinling & Co., Ltd., Imp.

UNDULANT FEVER IN THE NAVAL, MILITARY AND CIVILIAN POPULATIONS OF MALTA

BY

J. W. W. STEPHENS

(*Received for publication* 10 *February*, 1922)

In the previous paper Zammit has considered the prevalence of undulant fever* in the goat in Malta. As complementary to that paper I thought it would be of interest to present afresh the data as to the prevalence of the fever in the Mediterranean Squadron, Army (Malta Garrison), and civilian population of Malta respectively previous to 1906, and from that time onwards so far as data are available. 1906 is the critical year in regard to the relationship of undulant fever and goats' milk, for it was mainly in the latter half of that year that orders affecting the use of goats' milk came into force.

I have prefaced each section of the paper by some remarks, with the object of elucidating the meaning of the figures presented; for it is difficult, in the case of many, if not all, vital statistics, to ascertain whether they really represent what they are supposed to do. In the present connection it is essential to know whether a case 'returned' as undulant fever is that fever or not. Undulant fever is among the select class of infections that can be diagnosed with certainty. It is probable not only that certainty has not been attained in many cases, but that the approach thereto is a variable one.

NAVY

MEDITERRANEAN SQUADRON

1. NOMENCLATURE:

The following terminology is used in the 'Statistical Reports of the Health of the Navy':—

Other Continued Fevers is used from 1900-1906 and signifies fevers other than enteric and Mediterranean, influenza appearing under its own heading.

Pyrexia replaces 'Other Continued Fevers' in the tables from 1907-1914.

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* In the 'Nomenclature of Diseases,' Royal College of Physicians, London, 1897, 3rd Edition, appears the entry, *Mediterranean Fever*, synonym *Malta Fever*.
In 1918, 5th Edition, the entry, *Mediterranean Fever*, synonym *Undulant Fever* is used.

Simple Continued Fever is also used synonymously with Pyrexia in the text in 1909.

Sand-fly Fever. In the report for 1910, p. 50, it is stated that of the 98 cases of 'Pyrexia' in that year 58 were 'Sand-fly Fever.'

Cerebro-spinal Fever has a separate heading in 1912.

Mediterranean Fever is used in the tables from 1900-1906 and from 1910-1914.

Malta Fever is used in the tables and text from 1907-1909.

2. DIAGNOSIS:

1900. 'Agglutination adopted as a routine practice in the Army and shortly after in the Navy.'

(*Report of the Commission on Mediterranean Fever*, Pt. II, 1905, p. 12.)

3. GOATS' MILK:

(*a*) Naval Hospital.

1906—April 9. 'More stringent measures taken at the Royal Naval Hospital for the sterilisation of goats' milk.'

1906—July 23. 'Preserved milk substituted for goats' milk.'

(*Statistical Report of the Health of the Navy*, 1906, p. 120.)

(*b*) The Fleet.

1906—May 23. 'The Commander-in-Chief promulgated a general memorandum to the effect that as a guarantee of sterilisation the ortol and peroxide of hydrogen test should be used in all ships.'

1906—Aug. 4. 'The Commander-in-Chief repeated the order that all milk obtained in Malta was to be boiled. It was then to be tested by the ortol test.'

(*Commission Report*, Pt. VII, 1907, pp. 72 and 73.)

4. ESTIMATED STRENGTH:

The figures for the *average strength* refer to the *Mediterranean Squadron* and not simply to Malta, so that the rate per 1,000 is not comparable with that of the garrison or civilian population of Malta. These figures are *corrected for time*, i.e., if 1,000 men have been in the Mediterranean Squadron for six months and 500 for one year, the average strength per annum is 1,000: or again, if 365 men have been in the Squadron for one day and one man for 365 days, the average strength per annum is 2.

TABLE I

Showing prevalence of Undulant and certain other fevers in the Mediterranean Squadron, 1900-1914

Year	Average strength corrected for time	Cases		Rate per 1000 per annum	
		Mediterranean fever	Other continued fevers	Mediterranean fever	Other continued fevers
1900	14250	317	351	22·2	24·6
1901	14070	252	323	17·9	22·9
1902	18470	354	433	19·1	23·4
1903	18410	339	287	18·4	15·5
1904	19590	333	401	17·0	20·4
1905	14360	270	174	18·8	12·1
1906	12130	145	99	11·9	8·1
			Pyrexia		Pyrexia
1907	10530	14	110	1·3	10·4
1908	9780	6	119	0·6	12·1
1909	9920	11	69	1·1	6·9
1910	9850	3	98	0·3	9·9
1911	9770	5	144	0·5	11·7
1912	7870	3	49	0·3	6·2
1913	7580	2	38	0·2	5·0
1914	10220	6	34	0·5	3·3

ARMY

MALTA GARRISON

1. NOMENCLATURE :

The following terminology is used in the Army Medical Department Reports :—

Other Continued Fevers is used in *the statistical tables* for the years 1897-1907.

Simple Continued Fever is used as one sub-division of 'Other Continued Fevers' in *the text* from 1897-1907, the other sub-division being Mediterranean fever from 1897-1903, and Malta fever from 1904-1907.

Pyrexia of Uncertain Origin (P.U.O.) replaces ' Simple Continued Fever ' in the statistical tables and in the text for the years 1908-1914.

Sand-fly Fever appears in the tables and text for 1910-1914.

Mediterranean Fever is used in the text from 1897-1903 and also from 1910-1914.

Malta Fever is used in the tables and text from 1904-1909.

2. DIAGNOSIS :

1900. ' Agglutination adopted as a routine practice in the Army and shortly after in the Navy.'

(*Commission Report*, Pt. II, 1905, p. 12.)

Major-General Sir William Leishman, K.C.B., F.R.S., has informed me that the diagnosis of undulant fever is always based on the agglutination reaction.

3. GOATS' MILK :

1905. It is stated that in 1905 ' orders were issued by commanding officers that all goats' milk for the use of the men in barracks was to be boiled.'.

(*Commission Report*, Pt. VII, p. 168.)

1905—September. The attention of officers commanding was called to the fact that ' in some corps goats' milk had not been boiled before use ' (p. 169).

1906—May 16. The ortol test for detecting unboiled milk was in use and ' during the next three weeks neglect of boiling goats' milk was detected on six separate occasions ' (p. 170).

1906—May 12. ' Orders were issued for the discontinuance of the use of goats' milk in the military hospitals as a tentative measure, and for its replacement by condensed milk.'

' This change came into operation in the various hospitals between May 18 and 22, and at the same time the use of goats' milk by the various detachments of the Royal Army Medical Corps also ceased ' (p. 172).

1906—June. ' By the end of the first week in June all the units of the garrison were using condensed milk, with the single exception of the 1st Battalion Rifle Brigade, which continued to use goats' milk up to October ' (p. 173).

TABLE II

Showing prevalence of Undulant and certain other fevers in the Malta Garrison, 1897-1914

Year	Average strength	Cases: Mediterranean fever	Cases: Simple continued fever		Rate per 1000 per annum Mediterranean fever
1897	8023	279	1275		34·7
1898	7390	199	1510		27·1
1899	7425	275	1107		37·0
1900	8140	158	1158		19·4
1901	8136	253	12[illegible]5		31·1
1902	8758	155	1029		17·7
1903	8903	404	786		45·4
			Other continued fevers		
1904	9102	320	1350		35·1
1905	8294	643	1199		77·5
1906	6661	161	508		24·1
1907	57[illegible]	11	323		1·9
			Pyrexia of uncertain origin		
1908	603[illegible]	5	303		0·82
1909	6392	1	285		0·15
				Sand fly fever	
1910	6769	0	26	124	0·0
1911	6686	0	14	125	0·0
1912	6593	3	5	104	0·45
1913	6336	3	25	72	0·47
1914 (7 months only)	3487	1	0	51	0·28

CIVILIAN POPULATION OF MALTA

1. NOMENCLATURE :

'All fevers lasting more than a week are notifiable by law.'

'Mediterranean fever is generally notified under the name of remittent fever.'

(*Commission Reports*, Pt. II, 1905, p. 15.)

It appears from the above Report that in the civil official notification returns, cases notified under the name 'continuous fever' are included in the Annual Public Health Reports under heading 'Mediterranean fever.' We find the following terminology employed in the Public Health Reports :

Remittent Fever is used (for Mediterranean fever) in the Reports for 1897 and 1902-03.

Continued Fever, in addition to remittent fever, or Mediterranean fever, is used in the Reports for 1897, 1906-07, and (apparently synonymously with febricula) 1907-08, and then disappears.

Febricula, in addition to remittent, or Mediterranean, fever, is used in the Reports from 1898 to 1906-07 and then disappears. The number of cases for the five years, 1902-03 to 1906-07, was 66, 35, 26, 22, and 42 respectively.

Undulant Fever (for Mediterranean fever) first appears in the Report for 1912-13.

The terms 'Simple continued fever,' 'Pyrexia of uncertain origin,' and 'Sand-fly fever' do not appear in any of the reports.

2. DIAGNOSIS :

That the agglutination test is in use for purposes of diagnosis appears from the Public Health Reports, for in the Report for 1912-13, p. 30, it is stated that '636 samples of blood were submitted by private medical practitioners for the agglutination test of cases of fever.'

3. GOATS' MILK :

1907-08. The use of boiled goats' milk adopted in the Central General Hospital.

(*Annual Report, Public Health Department*, 1908-09, p. 5.)

1909—June. Regulations were issued apparently at this time requiring that all milk sold in shops, restaurants, etc., be boiled, but it appears from the Public Health Reports (1911-12, p. 43) that 'it is very seldom that the law is complied with.'

TABLE III

Table showing prevalence of Undulant fever and Febricula in the civilian population of Malta, 1902-03 to 1919-20.

Year	Population	Cases		Rate per 1000 per annum Undulant fever
		Undulant fever	Febricula	
1902-3	193,315	589	66	3·0
1903-4	197,070	573	35	2·9
1904-5	202,134	663	26	3·3
1905-6	205,059	822	22	4·0
1906-7	206,689	714	42	3·4
1907-8	209,974	501	6*	2·7
1908-9	212,888	463	...	2·1
1909-10	215,879	463	...	2·1
1910-11	213,395	297	...	1·7
1911-12	215,332	275	...	1·2
1912-13	216,617	370	...	1·7
1913-14	216,879	338	...	1·5
1914-15	218,542	321	...	1·4
1915-16	220,968	473	...	2·1
1916-17	223,741	495	...	2·2
1917-18	224,326	429	...	1·8
1918-19	224,655	363	...	1·6
1919-20	224,859	619	...	2·7

* 'Continued fever.'

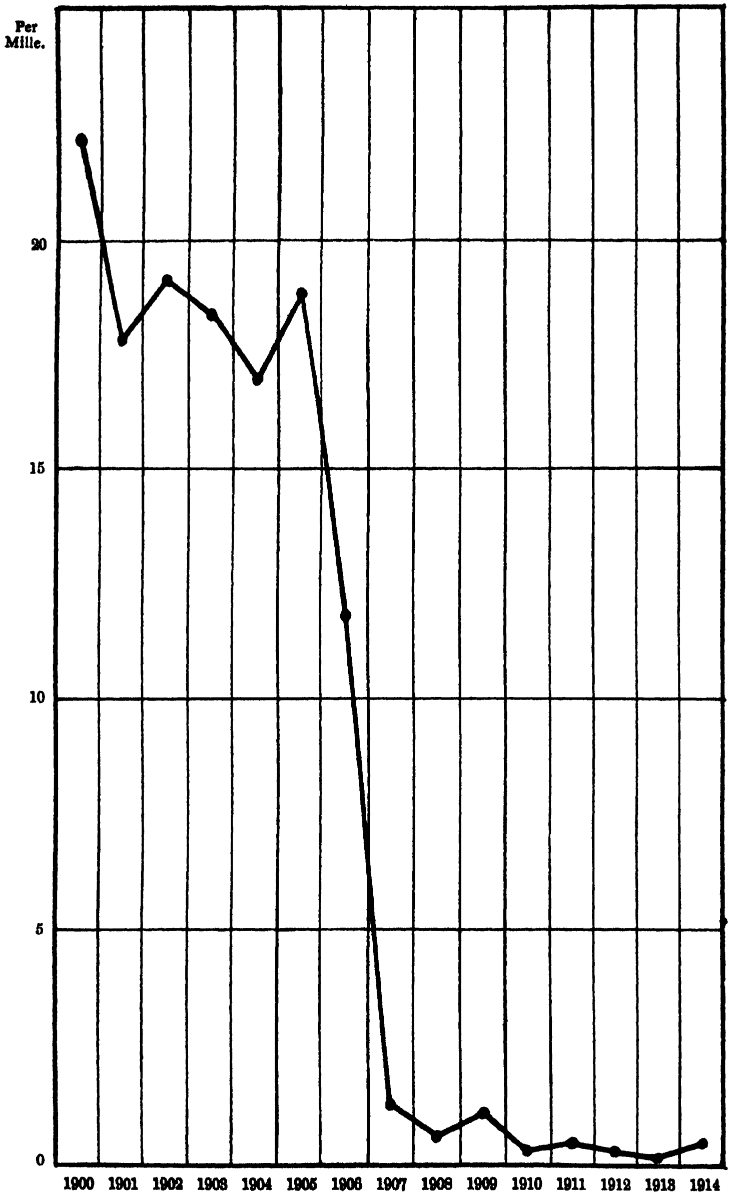

CHART I. Showing incidence of Undulant Fever in the Mediterranean Squadron.

N.B.—One division of this scale represents 5 per 1000.

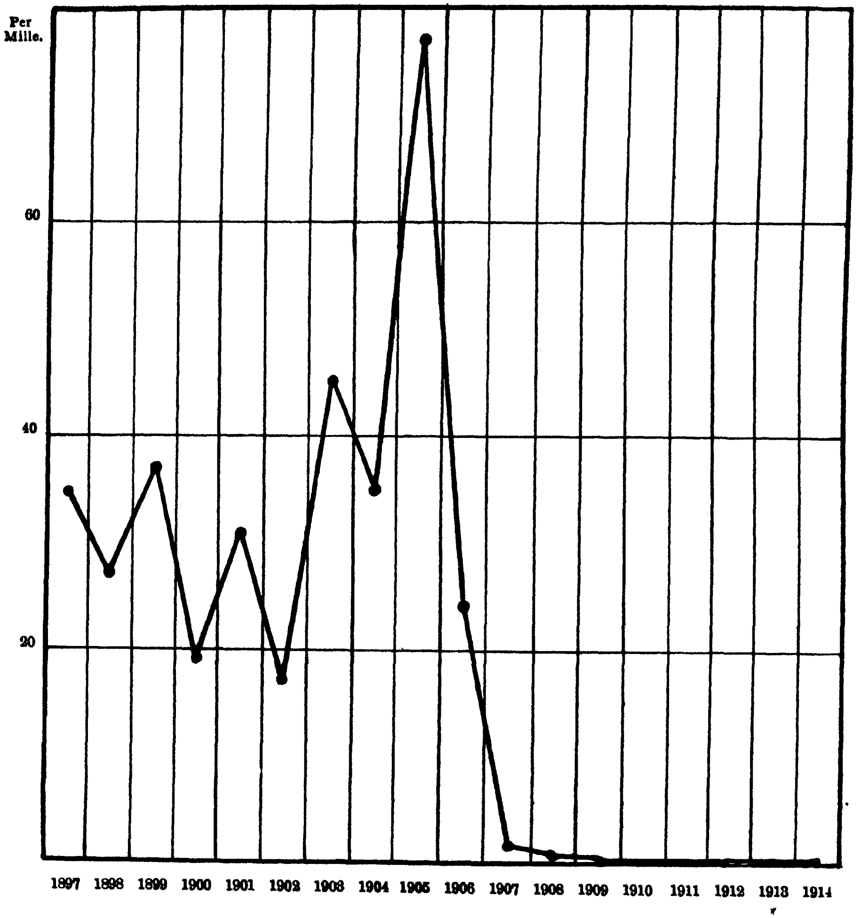

CHART II. Showing incidence of Undulant Fever in the Malta Garrison.

N.B.—One division of this scale represents 20 per 1,000.

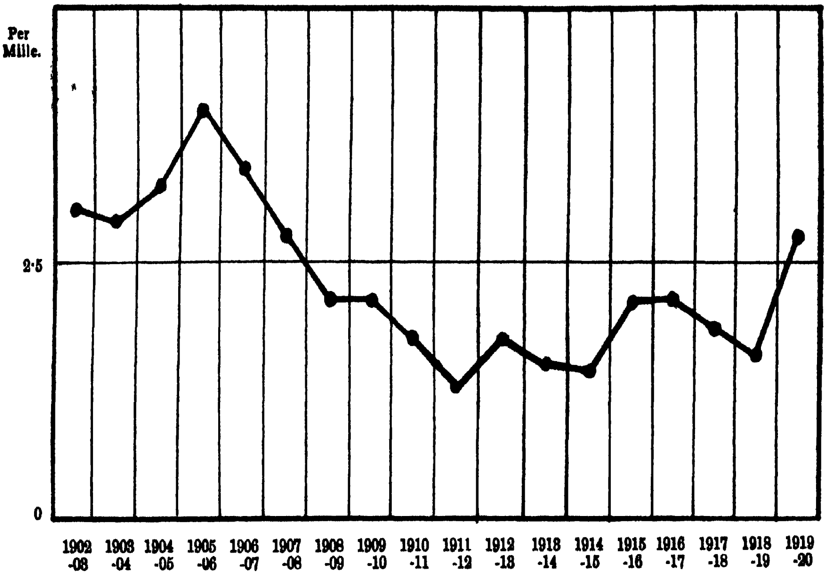

CHART III. Showing incidence of Undulant Fever in the Civil Population of Malta.

N.B.—One division of this scale represents 2·5 per 1,000.

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ALASTRIM; OR, KAFFIR MILK POX

BY

L. M. MOODY, M.D., B.S., M.R.C.P. (Lond.)

GOVERNMENT BACTERIOLOGIST, KINGSTON, JAMAICA

(*Received for publication* 19 *December*, 1921)

PLATES III-VII

For some months before my arrival in the Colony an epidemic of an eruptive fever described as Alastrim, or Kaffir Milk Pox, broke out in Kingston, and from Kingston spread to the other parts of the Island. From about May, 1920, to the end of March, 1921, two thousand nine hundred and twelve cases have passed through the Isolation Hospital at Bumper Hall, Kingston, and about six thousand have occurred throughout the Island.

In the following paper I propose to consider:—

I. CLINICAL ASPECT

Incubation period. Owing to the difficulty of getting cases in which exposure occurred only once, and that for a short time, it has been impossible to determine the exact period of incubation; but in those in which I was able to get some definite history of exposure the incubation period varied from ten to about fourteen days.

The evidence on which this conclusion is based is as follows:—

CASE 1. A.H. Not vaccinated. He was in Kingston for three days during July when the epidemic was limited to Kingston only, and returned to his country district, where no cases had hitherto occurred. The symptoms developed 10 days after his return.

CASE 2. Photographer E. Not vaccinated. He attended with me at the Isolation Hospital and took his first set of photographs on July 20th, 1920. During this visit he placed his focussing cloth, before using it, on a chair which had been previously occupied by a patient. Ten days later he again took a photograph, and 3 days after the 2nd photograph he developed symptoms. He was positive

that these were the only two occasions on which he was exposed. Fortunately, his case proved to be mild in character.

CASE 3. Nurse at the Isolation Hospital. Not vaccinated. She complained of headache and pain in the back 14 days after she took up duty. So far as she knows she had not previously been exposed. The disease ran its usual course. This case had been exposed to infection several times before symptoms developed and is only useful as determining the upper limit of the incubation period.

CASE 4. A boy at school in Kingston. He developed symptoms at Annotto Bay 11 days after leaving his school in Kingston. He stated that a number of cases of Alastrim had occurred at his school, but he did not know when he had himself been exposed to infection. He was the first case which occurred in Annotto Bay, and like Case 1, was directly traceable to Kingston.

The remaining cases are not so definite.

CASES 5-7. During their stay at the Isolation Hospital a number of pregnant women suffering from Alastrim gave birth to children. Three of these cases I saw. The infants at birth were free of all signs of the disease. They were breast-fed by their mothers, and the rashes appeared on the 10th, 11th, and 12th days after birth respectively.

Not much weight can be attached to this evidence because intra-uterine infection could not definitely be excluded. I say this because later on in this paper I shall instance such cases in which infants were born with the rash well developed.

Failing more definite evidence, the period of incubation can therefore be placed provisionally at from ten to fourteen days.

Onset. The onset of the disease is sudden. There is a rise of temperature accompanied by headache and backache, and occasionally pains in the limbs and vomiting. The rise of temperature was constant.

Of two hundred and two cases of both sexes (one hundred and thirty-three males and sixty-nine females), the incidence of the various symptoms of onset were as follows:—

Headache ...	...	172 cases, or about	85 per cent.
Backache ...	...	111 ,, ,, ,,	54 ,,
Pain in limbs	...	41 ,, ,, ,,	25 ,,
Vomiting ...	...	32 ,, ,, ,,	16 ,,

The headache, when present, was generally severe, and often either frontal or vertical.

Of the one hundred and eleven cases in which backache occurred, only forty-five described their pain as severe; the remaining sixty-six described it as moderate. Backache was relatively far more frequent

among the women than among the men; 70 per cent. of the former complained as compared with only 45 per cent. of the latter, and twenty-seven of the forty-five severe cases were among the sixty-nine women. The greater incidence of backache among the women is probably due to the fact that many of them were victims of chronic endometritis, and magnified their usual backache symptoms.

The combination of headache, vomiting and pain in the back occurred in only twenty-one of the two hundred and two patients, and of these only six vomited more than once, and only one more than three times. In the majority of cases the tongue was furred and constipation was present.

Other manifestations. The characteristic eruption appeared with about equal frequency on the third or fourth day after the onset of the symptoms. The actual figures are as follows:—

In 21	cases	the	rash	occurred	on	the 2nd	day.
In 75	,,	,,	,,	,,	,,	3rd	,,
In 70	,,	,,	,,	,,	,,	4th	,,
In 36	,,	,,	,,	,,	,,	5th	,,

Either shortly before or after the appearance of the rash, the temperature falls and the constitutional symptoms disappear. The patient is then quite at ease until maturation begins, when for two or three days there is a great deal of pain from the tension under the skin. In a number of cases there is also secondary fever. No prodromal rashes were seen. Delirium was never observed. The deep depression which occurs at the onset of true smallpox was uniformly absent.

Menstruation did not appear in the women unless a period was due, and even then no one complained of more than her usual loss of blood.

Odour. There was an absence of odour such as is produced by smallpox. A few cases, however, developed a distinctly putrefactive smell, which was due to decomposing discharges.

Pain in the throat and dysphagia, accompanied in some cases by aphonia and enlargement of the glands of the neck, were noted as occurring in a number of cases. These symptoms were due to the presence of the eruption on the fauces, and presumably in the larynx and trachea.

Sputum. Three cases had bronchitic signs in the chest, and for a few days coughed up blood-stained sputum.

Bowels. In two cases there was profuse diarrhoea at the onset, but the majority were constipated.

Urine. In fifty cases whose urines were examined albuminuria was absent, unless due to some other cause, such as urethral or vaginal discharge. Unfortunately, no urines were obtained before the eruption appeared, and in none of the cases was the examination performed more than once. In one case of diabetes, the eruption ran the usual course, but was followed by a large number of boils.

Eruption. Patients do not usually come under observation until the rash is well developed; but in two cases which were admitted to the Isolation Hospital in the pre-eruptive stage the rash appeared in the form of small papules, which to the touch were superficially situated: the papules becoming vesicular in about thirty-six hours.

The vesicles are circular in shape, and when fully mature are from 4 to 5 mm. in diameter. The summit is either dome-shaped or flattened, and frequently shows a darkened central area. In the early stages the vesicles, if pricked, yield a clear serum quite free from cells, but polynuclear leucocytes begin to appear in the fluid on the second or third day, and gradually increase in numbers until turbid fluid, or even sometimes thick pus, is formed. At this stage the lesion is very tense, hard and shotty.

In the lighter coloured skins a definite red areola surrounds each pock. Primary umbilication is not often, if ever, seen, but on about the eighth or ninth day a secondary umbilication or flattening takes place, and is due to resorption of fluid.

The eruption is subject to variation, but, broadly speaking, two main types are distinguishable; the one type being finer and more closely set, and the other being larger and more distinct. Sometimes both types are found in the same patient, the vesicles then presenting a very unequal appearance.

The finer eruption has far less tendency to form thick pus, but the general course was similar to that of the larger variety.

A number of confluent and two haemorrhagic cases occurred in this series (altogether four cases of haemorrhagic rash have been brought to my notice, all occurring in women six to seven months pregnant, and all fatal).

Distribution of the rash. The rash makes its appearance or, at all events, is first noticed in certain positions. These are in order of frequency, the face, especially the forehead, and the dorsum of the wrist or forearm.

Of the two hundred and two cases, the location of the onset, as noticed by the patient, was as follows:—

Face	120
Wrist and forearm	52
Both arm and face	27
Scrotum	1
Inner side of knee	1
Elbow	1

Although in severer cases, as in Plate III, the whole body may be covered, the rash shows a predilection for certain areas. It especially tends to affect the face, the lower half of the back, and the arm and forearm, especially towards the wrists.

Scalp. The rash was present on the scalp in all the cases examined; the lesions, however, were often few in number.

Mouth. Pocks were frequently seen on the hard and soft palate, and to a less extent on the pillars of the fauces and the inside of the cheeks. In four cases the fraenum linguae was also affected.

Larynx. Hoarseness of voice and sometimes aphonia were present in the majority of the severe cases, and in a fair proportion of the other cases. Laryngoscopy was not possible, but in three of the cases pocks were present in the larynx and trachea—post-mortem.

Palms and soles. In all the two hundred and two cases pocks were seen on the palms and soles. In some these were abundant and caused much pain and discomfort. No lesions under the nails were noticed.

Genitalia, especially the prepuce, were often affected, and there was in a few cases much swelling and pain and difficulty of micturition.

Plates IV and V show that the rash is present on the area between the knee and the ankle. In true smallpox this area is described as being often free from rash.

The parts on which the distribution of the rash is often comparatively slight are:—

1. The neck.
2. The upper part of the trunk, and the abdomen.
3. The inner side of the thighs.
4. The circumorbital area.

In this latter situation there is frequently no rash at all, even in severe cases, though pocks are often seen on the edge of the lids. No pocks were seen on the conjunctiva.

The effect of irritation appears to be to determine a plentiful outcrop of rash (Plate V).

The course. The rash does not appear in crops, but it is often two or three days before the full extent of the eruption is obvious. The order in which it affects the various parts of the body is similar to that of true smallpox. After its appearance it gradually passes through the vesicular stage, already described, until it reaches maturity at about the sixth or seventh day. There is no tense shotty feeling until the rash is nearly matured.

This maturation is accompanied by oedema of the subcutaneous tissues. In the majority of cases this oedema is slight, but in others it is so great as sometimes completely to close the eyes. The oedema appears on the third or fourth day of the rash, reaching its height on the seventh or eighth day, and rapidly disappears (Plate VI).

Resorption of fluid begins to take place on about the eighth day, and convalescence is so rapid in many cases that by the twelfth day nearly all the scabs have fallen off the face. The rash disappears in the same order in which it appears, and in uncomplicated cases all the scabs have fallen at latest by the end of the third week.

In yet other cases the pigmentation is around the scar, the scar itself being achromic. In yet other cases, in fair skins there has been no subsequent pigmentation. In my opinion, the pigmentation is not of much import, in that the normal negro tends to deposit excess of pigment in and around scars. At first I thought that the pigmentation was the result of local treatment, but changed my mind when I saw the same thing in the scars of two infants born alive after intra-uterine alastrim.

The Temperature. The onset of the disease is marked by a rise of temperature, which may reach 104° or even 105°, but in most cases is about 103°. This temperature persists with but slight variations for three or four days, then rapidly falls to normal as the rash appears. Sometimes the fall of temperature completely

precedes the appearance of the rash, at other times both take place co-incidently. The temperature then remains down for four or five days, to rise again as the rash matures In mild cases there is no

CHART I.—Mild case of Alastrim No secondary fever. Acute onset

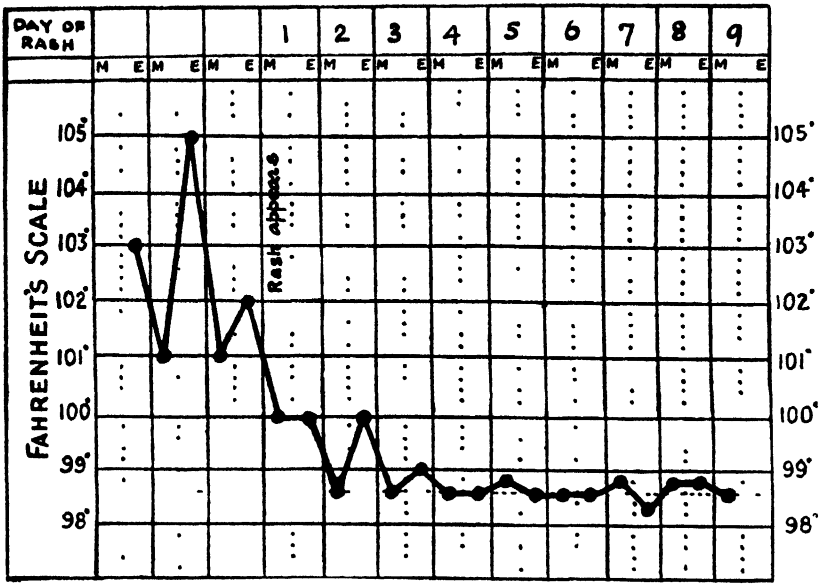
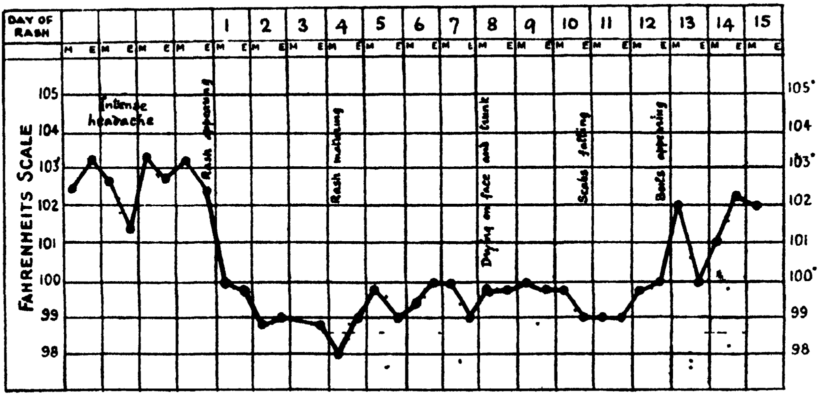


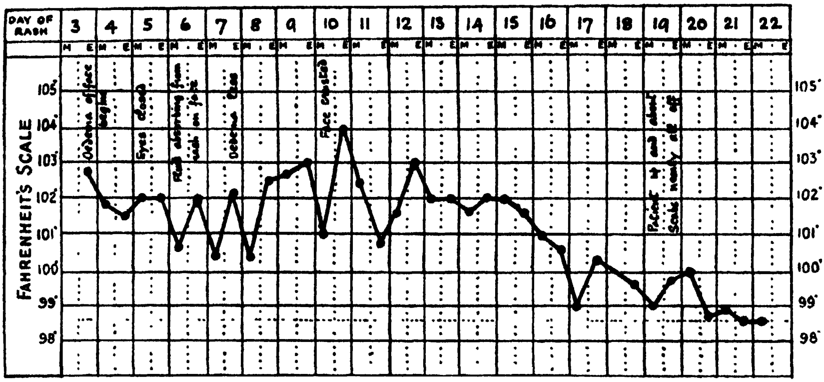
CHART II —Medium case of Alastrim



secondary rise of temperature, and in the severe cases the rise appears to be in some way dependent on the extent of the vesicles and the amount of infection with skin organisms. There is only a

slight rise when the pus is practically free from organisms, and a greater rise when there are many. In milder cases secondary fever is absent. A curious point about this secondary fever is that the patient is not conscious that he has a temperature, though his temperature may be as much as 102°. After persistence for a few days the temperature returns to normal, and stays there unless complications, such as boils, occur. The secondary fever is as a rule very mild.

CHART III.—Case of Alastrim exhibiting 'Typhoid' type of chart.



There is, however, another type of temperature which has been noted in a few of the very severe cases, and this approximates to the typhoid type, persisting for fourteen or fifteen days before falling to normal.

The temperature of onset is no indication of the severity of the disease, high temperatures being often succeeded by a scanty rash.

Complications and Sequelae.

Broncho-pneumonia is the most serious. It occurred in some of the fatal cases in which much rash was present in mouth and respiratory tract, and was probably due to aspiration of septic material.

Laryngitis and aphonia occur in the severer cases, but disappear as the rash disappears.

Conjunctivitis of a mild type develops in a number of cases, and is due to infection from the discharges of lesions on the eyelids.

Impetigo. Six cases developed impetigo when the rash was disappearing. In severe cases large areas of skin are apt to be

stripped off, leaving raw surfaces which are very painful and troublesome to treat.

Boils are the most frequent sequel. They appear at about the fifteenth day after the onset of the rash, and may persist for weeks.

Eczema of an intractable character of the external auditory meatus has also been noted.

Prognosis is good, except in the newly born and in the haemorrhagic type of rash.

Of two thousand nine hundred and twelve cases which have passed through the Isolation Hospital up to the end of March, 1921, there have been only thirteen deaths, an average of 4·5 per 1,000.

In eight of these cases the condition was as follows:—

Two women who were 6-7 months pregnant with a haemorrhagic rash. One bled profusely from nose and mouth, vagina and bowel; and both post-mortem showed internal haemorrhages.

One man who was 56 years old and died during convalescence.

One man who died after admission, but showed no signs of alastrim.

One man admitted in a dying condition. He had extensive confluent lesions with skin stripping and leaving large raw surfaces. He could hardly breathe. The mouth was very septic, and the smell from putrefying discharges was very offensive.

Three children all within the first month of life and manifesting the disease within the first fortnight of birth.

II. OCCURRENCE IN THE FOETUS

The virus passes fairly readily through the placenta into the foetal circulation.

Up till February, 1921, of twenty cases admitted, after attacks of alastrim, to the Jubilee Maternity Hospital, eight cases of abortion at about the sixth month have occurred, and in each case the macerated foetus was marked with scars of the disease. Two of the cases I was able fully to investigate, and in these the abortion occurred eight weeks after the onset of the disease in the mother. All the organs were searched for spirochaetes without result, and the Wassermann reaction of the blood of the mothers was negative. The scars in the foetus were slightly depressed.

In addition, two children were born alive with marks of alastrim. The first child was born at full term with marks present as follows:—

Face	9 marks.
Trunk (front)	10 ,,
Trunk (back)	12 ,,

A few on each leg and arm.
Two on each sole and one on each palm.

These scars were depressed and surrounded by pigmentation. The mother of this child was alone in the world and developed eclampsia, and died soon after the birth of the child, so that it was impossible to obtain an accurate history. Scars and pigmentation such as occur after alastrim were, however, present on her body.

The second child was born at the seventh month and had no sign of disease on the face, but six spots on the left arm and seven on the right, with three on each leg. These scars were pigmented, as is the case in adults.

The mother's attack occurred eight and a half weeks previous to the birth of the child. The mother's Wassermann reaction was negative.

In none of these cases of foetal alastrim was the disease very severe in the mother, judging by the amount of scarring and pigmentation present.

The remaining ten labours yielded normal, full term children, two of which developed alastrim a day after labour. In addition, two remarkable cases have occurred in which mothers who had been vaccinated, who have never had alastrim, gave birth to children covered with an alastrim rash.

Both cases present a very similar history, save that one mother was vaccinated six weeks and the other four weeks before labour. I give the details of the second case.

'P.C.,' age 23. Sailed from Cuba, January 10th, for Jamaica; was vaccinated on the day of sailing. She landed in Jamaica January 12th, and had fever on 14th and 15h January. So far as she is aware she has never come into contact with any active cases of alastrim. On February 10th (day of examination) the scab had not yet fallen off her vaccination mark and covered an area a little larger than that of a threepenny-bit. She had no signs either in the way of scars or pigmentation of having had alastrim.

The child was born at full term with a pustular eruption (Plate VII), and died five days after birth. Mother and child gave negative Wasserman reactions.

These are cases either of generalised vaccinia occurring in utero

or of alastrim transmitted to the foetus by a mother rendered immune by vaccination. If they are cases of generalised vaccinia they demonstrate that ordinary vaccination can be so transmitted; if they are cases of alastrim, it would appear that just as the diphtheria bacillus grows readily in diphtheria antitoxin so the organism of alastrim can flourish in the blood of one who has, by vaccination, been rendered immune to its toxin, can retain its virulence, pass through the placenta and affect the foetus.

There is finally the possibility that the disease may have existed in the mother, but was so mild as to have been completely overlooked even by herself. If the incubation period be regarded as twelve days, and if the mother were infected on the twelfth day, the day of landing in Jamaica, she ought to have manifested symptoms on January 24th, at a time when, on general principles, she would have been completely protected by vaccination. The child at birth had a rash of at least five days' duration, and if another three days are allowed before the rash appears, must have been manifesting symptoms in utero by the 2nd February. If the child were infected twelve days previous to the manifestations of symptoms, the time relations would be about right. But as against this conclusion, the mother maintains that, apart from slight fever on the fourth and fifth days after vaccination, she was perfectly well. Moreover, I have not seen a mild case of alastrim in which there has not been some malaise. Of the three mildest cases which came under my notice one had four and two had two pocks each, yet in each of these cases the eruption, such as it was, was preceded by fever and malaise. Therefore, pending further evidence, I am of opinion that these cases illustrate the possibility of an immune mother transmitting the disease to her unborn child.

In connection with the question of foetal alastrim, I am impressed by the relatively high frequency with which it occurred among the cases of labour admitted to the Jubilee Hospital. Of twenty cases, ten produced alastrim foetuses, two produced infants developing the disease one day after birth, and only eight produced normal infants.

III. ITS RELATION TO VACCINATION

The following two tables summarize the facts in two hundred and six adults and eighty children taken at random:—

ADULTS (206)

Cases		Mild	Medium	Severe
		%	%	%
With vaccination scars	72	47·2	30·5	22·2
Without vaccination scars	134	28·3	34·3	37·3
Total	206	35·0	33·0	32·0

CHILDREN (80)

Cases		Mild	Medium	Severe
		%	%	%
With vaccination scars	26	84·6	15·4	0·0
Without vaccination scars	54	44·4	25·9	29·6
Total	80	57·0	23·0	20·0

It will thus be seen that:—

1. There is a tendency to a mild type of case in children, due partly to vaccination and partly to some other factor.

2. No severe case occurred in the vaccinated children of this series, and twenty-two of the twenty-six (84·6 per cent.) vaccinated were mild cases.

Professor MacCallum and myself were continually exposed to infection for hours at a time, but never contracted the disease. We were both vaccinated, he recently and myself five years ago. One of the helpers at the Isolation Hospital was vaccinated by me before taking up duty. I frequently watched her handle the patients and

lateral one longer than the others; the middle, distal one shortest; the segment about half the length of the proximal one. Inferior claspers slightly shorter than the proximal segment of the superior claspers.

Length 2·3 mm.; length from front of thorax to end of armature 1·8 mm.; wing, 1·3 mm.; leg III, 2·6 mm.; internal genital armature, 0·6 mm.

Female. More robust and generally larger than the ♂. *Abdominal hairs* more or less erect. *Palpi* similar in form to those of the ♂. Third segment of *antennae* shorter than the corresponding segment in the ♂, and not reaching the tip of the proboscis. *Wings* (fig. 1 *c*) much more broadly lanceolate than in the ♂; curvature of the borders similar; venation similar to that of the ♂. *External genitalia* (fig. 1 *d*): the superior leaf-like appendages relatively exceptionally large and, in macerated specimens, widely separated from the inferior pair; both appendages strongly hairy; the inferior pair with the finer hairs on the distal two thirds arranged in distinct, equidistant rows.

Length, 2·1 to 2·9 mm.; length to front of thorax, 1·7 mm.; wing, 1·6 mm.; leg III, 3·1 mm.

Two American species: *P. vexator*, Coquillet (1907) and *P. brumpti*, Larousse (1920), resemble this species in regard to the number of spines on the superior claspers. In *brumpti*, however, the armature generally resembles that of *P. papatasii*, and is, therefore, markedly distinct. *P. vexator* also differs in having the spines arranged as follows: two apical, *two sub-apical*, and *one in the middle* of the segment. In *P. trinidadensis*, sp. n., the formula is three apical and *two* near the middle of the segment.

TRINIDAD. Six ♂♂, seven ♀♀ (four of which contained blood), 1921. Major W. F. M. Loughnan, R.A.M.C., D.A., D.P., West Indian Command, with the assistance of Captain D. A. MacDougall, M.C., R.A.M.C.

In his letter from Kingston, Jamaica, dated 22nd August, 1921, Major Loughnan states that he, together with his fellow-officer, had a good deal of trouble in finding the specimens, and further that the species appeared to be very sparse in its distribution in the Island of Trinidad.

This is the first authentic record of the occurrence of a species

of *Phlebotomus* from the West Indies; and the captors are to be congratulated on their interesting discovery. Possibly other new and undescribed species await the hunters of these small midges in that region.

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A NEW TSETSE-FLY FROM THE SOUTH CAMEROONS

BY

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AND

Miss ALWEN M. EVANS, M.Sc.

(*Received for publication* 10 *February*, 1922)

In the course of his investigations in the South Cameroons, during the past year, Dr. J. Hanington, a former member of the Staff of this School, made several small collections of tsetse-flies and other blood-sucking Arthropods. These he has generously presented to this Institution for the Museum collections. In the last consignment, which reached us towards the end of January of this year, were many examples of *Glossina palpalis*, R. D., *G. pallicera*, Bigot, and four specimens of a large species which, on microscopical examination of the morphological characters of the genital armatures, proved to be new and undescribed. In the letter accompanying the collection of flies, Dr. Hanington submitted a sketch-map of the districts through which he had passed, and gave the following brief account of the nature of the country in which the captures were made: 'The tsetse-flies were collected on my just completed tour of inspection N.W. over our border to Obudu. The country is hilly, forested, with many swift, shallow rivers, and full of tsetse. The large species is found only in the neighbourhood of Basho, where the ground begins to rise to the north into fly-free mountain-plateaux. The greatest number of tsetses were on the Mbilesi-Mateni Road, which runs along a wooded and rocky river valley.' The commonest species in this region would appear to be *Glossina pallicera*, of which twenty-six specimens were sent.

We append a description of the new species, and have ventured to dedicate it to Dr. Hanington, the discoverer, in recognition of his devotion to the science of tropical medicine.

Glossina haningtoni, sp. n.

A large dark-coloured species, with infuscated wings, belonging to the 'Fusca Group.' Hairs of the third antennal segment relatively short. Proboscis (palpi) 0·7 to 0·9 mm. shorter than in G. FUSCA. *Width of front in both sexes similar. Harpes of male each with three processes, the distal one angular and emarginate in front. Signum of female with height slightly exceeding width and paired crescentic folds almost continuous behind.*

Male: Length, 11 mm.; proboscis, 4 mm.; front of head, 0·75 mm.; wing, 11 mm. *Female*: Length, 11 to 12 mm.; proboscis, 4·2 mm.; front of head, 0·75 mm.; wing, 12 mm.

Male: Head with the posterior surface 'mouse-grey' (Austen), with a narrow black streak on the upper surface bordering the narrowly pale margin of the eyes. Vertex immediately behind the ocelli with a narrow black area. Front pale brown with a much paler area surrounding the ocelli. Antennal cavity greyish below, sides a little paler than the front. *Antennae* with the first two segments dark brown; the third pearly-grey, the tip of the segment moderately prominent, with the outstanding hairs forming the fringe in front from one-seventh to one-eighth the width of the segment. *Proboscis* relatively short, bulb uniformly pale buff-yellow. *Thoracic* markings very dark and pronounced, suture and ground colour forming the trident-like marking immediately in advance of the scutellum, pale ochraceous, the rest darker. *Abdomen*: Dorsum of first and second segment brown; the rest very dark, *glossy* sepia-brown, distal angles of last three segments ochraceous-grey; venter orange-ochraceous. Legs orange-ochraceous: leg I, with the femur infuscated along the dorsal half, tibia infuscated externally, tips of last two segments of tarsus dark brown or black; leg II, similar to the first but lighter in colour; leg III, with the third and fourth segments of the tarsi dusky, the last two all dark brown or blackish; all the ventral hairs dark golden. *Wings* rather strongly infuscated. *Genital armature* (fig. 1): Harpes (*h.*) with three bi-lateral processes; proximal pair long and spine-like, the first slightly shorter than the second; distal process angular, and when flattened by pressure shows a deep emargination on the distal margin (*h.* 1), but with the lower,

angular projection folded inwards the emargination almost entirely disappears (*h.* 2). Ventral chitinous sclerites long and projecting almost as far as the distal processes of the harpes. Inferior claspers (*i. c.*) normal, a few of the marginal hairs of great length. Median process with its distal edge rounded, and projecting slightly beyond the inferior claspers. Superior claspers (*s. c.*) relatively rather long, and as usual, bluntly bifid.

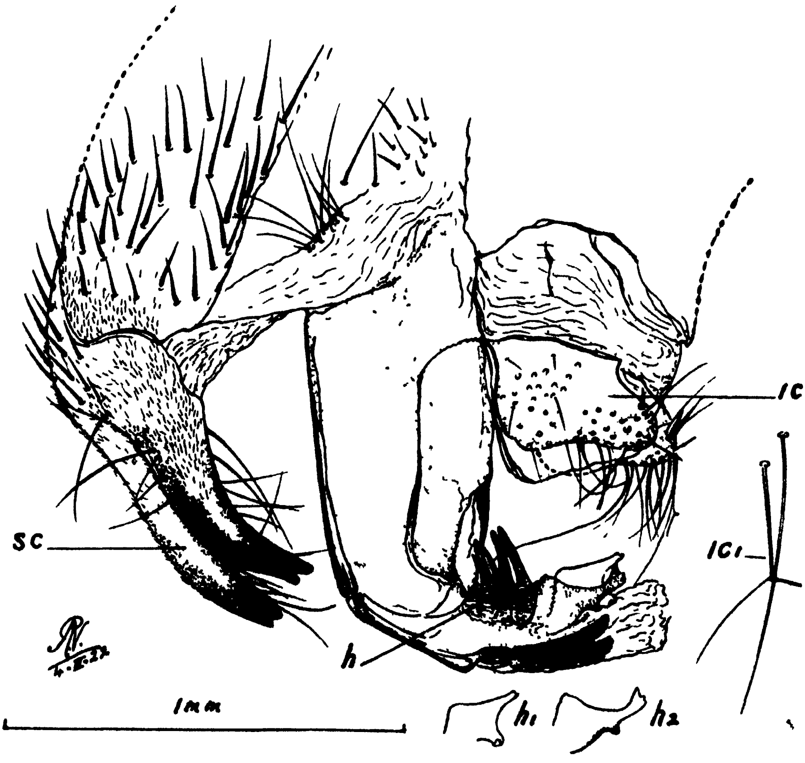

FIG. 1. *Glossina baningtoni*, Newstead and Evans. ♂ genital armature: *s.c.*, superior claspers; *i.c.*, inferior claspers, *i.c.l.*, two hairs from the inferior clasper, one of them malformed; *h*, harpes; *h.*1, distal process of harpe, with lower arm extended, internal aspect; *h.*2, the same with the lower arm curved inwards, external aspect.

Female. Third antennal segment pale ochraceous proximally, the distal three-fourths infuscated. Colour of legs, abdomen and plurae slightly darker than in the male. The 'black streak' on the posterior surface of the head absent. The space between the eyes (front) as in the male. *Genital armature*: External armature of the type found in *Glossina fusca* but the dorsal plates rather broad, the

width exceeding one-third of the length. Internal armature, signum of uterus (fig. 2) measuring 0·41 mm. in height and 0·38 mm. in greatest width. Median portion of signum (*m. p.*) a thin plate of the form shown in the figure, ochraceous brown behind, becoming straw-coloured towards the anterior margin; postero-lateral portions (*p. l. p.*) laminar, pale ochraceous, connected with the median plate by deep crescentic folds of black chitin (*c. c.*) These folds almost continuous posteriorly, and forming a striking feature of the signum.

SOUTH CAMEROONS: Basho, Mamfe (Ossidinge) Division, 14th December, 1921, 2 ♀♀; 2 ♂♂. Dr. J. Hanington.

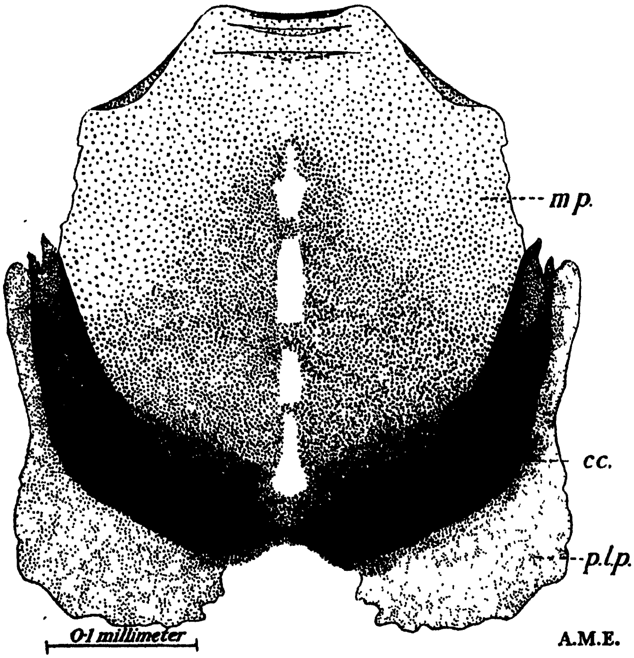

FIG. 2. *Glossina baningtoni*, Newstead and Evans. ♀ Signum: *c.c.*, crescentic fold; *m.p.*, median plate; *p.l.p.*, postero-lateral plate.

Closely related to *Glossina fusca*, but differing *externally* by the relatively much shorter palpi (proboscis), and the slightly more robust appearance. But the most marked morphological differences can be seen only in the genital armature of both sexes. A careful study of these organs at once reveals the strikingly distinctive features of this species, and its affinities with other members of the 'Fusca Group' of tsetse-flies.

NOTES ON AUSTRALIAN CESTODES

BY

P. A. MAPLESTONE

(*Received for publication* 10 *February*, 1922)

III. *COTUGNIA OLIGORCHIS*, n. sp.

On four occasions specimens of the cestode about to be described were found in the intestine of the Whistling Duck (*Dendrocygna arcuata*, Cuvier), shot a few miles from Townsville, North Queensland.

EXTERNAL ANATOMY.

The largest specimen measured 80 mm. long and 8 mm. broad at its widest part; these dimensions were taken from fixed material.

The scolex is relatively small and there is no neck. In well fixed specimens the worm is of almost uniform breadth for the greater part of its length, but tapers fairly rapidly and evenly both anteriorly and posteriorly. The posterior end is not unlike the anterior, except that it is not so finely pointed, owing to the absence of a scolex.

Head. The scolices were not well fixed, being in all cases more or less shrunken, so the detailed characters of this structure cannot be accurately given. However, it is seen to bear a very small retractile rostellum armed with a single row of minute hooks measuring about 10μ long, but unfortunately their exact number could not be determined, because all available specimens were imperfect. The four small suckers are situated quite near the anterior extremity, and measure about 0·65μ in diameter (fig. 1).

Segments. The proglottides are from first to last much broader than long.

INTERNAL ANATOMY.

Muscular system. On examining transverse sections it is seen that the muscle layers are disposed in the same way as in *Diploposthe laevis* (Bloch, 1872); Jacobi, 1896. That is, there are a few diagonal fibres externally, with a layer of transverse fibres internal to them. Next in order from without inwards is the main longitudinal layer, which consists of a large number of closely set

bundles oval in cross section, with their long diameters running dorso-ventrally, and about 0·50μ in thickness. This layer is evenly developed and encircles the segment, except where it is pierced by

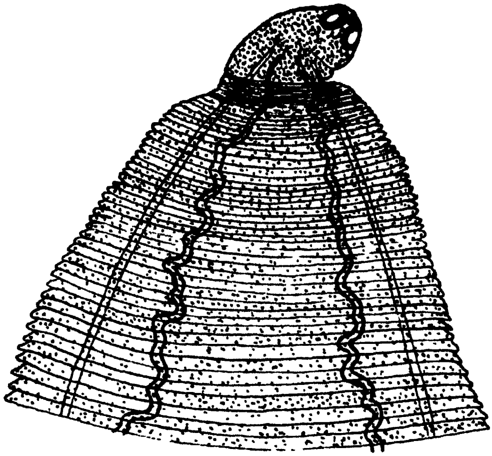

FIG. 1. *C. oligorchis*, n. sp. Scolex and anterior portion of strobila. × 35.

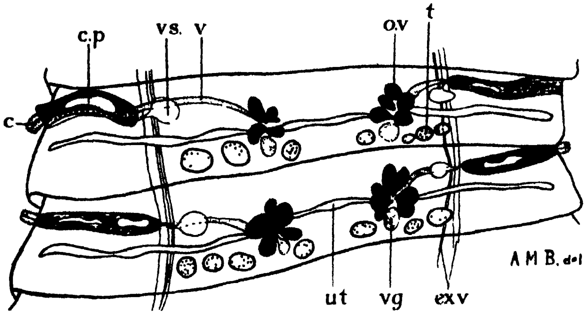

FIG. 2. *C. oligorchis*, n. sp. Mature segments. *c.*, cirrus; *c.p.*, cirrus pouch; *ex.v.*, excretory vessels; *ov.*, ovary; *t.*, testes; *ut.*, uterus; *v.*, vagina; *v.g.*, vitelline gland; *v.s.*, vesicula seminalis. × 20.

a cirrus pouch. Internal to this is another thinner layer of transverse muscle with a few scattered bundles of longitudinal muscle irregularly placed on the dorsal and ventral surfaces respectively, and about fifteen to twenty in number on each surface. Internal to these bundles are a few fibres of transverse muscle. It should be noted that the transverse muscle layers consist of hoop-like strands of fibres discontinuous with each other antero-posteriorly, so that in transverse sections they are only seen here and there. (Figs. 3

and 4 do not show the transverse fibres for this reason.) The dorso-ventral fibres are most marked in sections through the anterior and posterior of a segment.

Nervous system. The nervous system is poorly developed and consists of a small main nerve lying well to the outer side of the excretory canals, and ventral to the cirrus pouch and vagina.

Excretory system. The two lateral excretory canals on each side lie in the anterior portion at some distance from each other; the smaller dorsal vessel lies to the inner side of and dorsal to the ventral vessel. In this part of the worm the dorsal canal pursues a

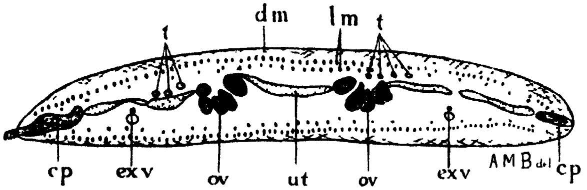

FIG. 3. *C. oligorchis*, n. sp. Transverse section through a mature segment. *c.p.*, cirrus pouch; *d.m.*, diagonal muscle; *ex.v.*, excretory vessels; *l.m*, longitudinal muscle; *ov.*, ovary; *t.*, testes; *ut.*, uterus. × 20.

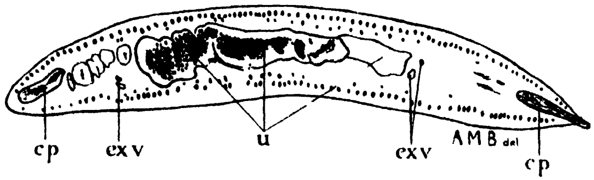

FIG. 4. *C. oligorchis*, n. sp. Transverse section through a gravid segment. *c.p.*, cirrus pouch; *ex.v.*, excretory vessels; *u.*, uterus. × 20.

wavy course, each wave extending over two or three segments, so that the width of the medulla varies slightly in different segments (fig. 1). More posteriorly it straightens out like the ventral vessel and pursues a direct antero-posterior course, and at the same time comes to lie close to the inner side of the latter. Throughout their whole length the canals are a considerable distance from the lateral borders of the worm.

Genitalia. The male and female organs lie in the medulla in two separate groups, one on each side of the mid-line.

Testes. The testes vary from three to five in number on each side and are situated posterior to the ovary, close to the posterior border of the segment in a transverse line. They measure about

80μ in diameter, but this dimension is only approximate, for when five are present they are smaller than when only three are present on each side. Their number and position in relation to the ovary (whether lateral or mesial to it) vary in different proglottides of the same chain, or even on the two sides of the same segment. Thus when there are three testes they may all lie external to the ovary, or there may be one internal and two external; if four in number they may lie, two internal and two external, or three external and one internal; and lastly, if five in number they may lie three external and two internal, or four external and one internal (fig. 2). They come to full development far in advance of the ovary, and are beginning to atrophy before this organ is fully developed.

Vas deferens. There is a small but distinct vesicula seminalis, which lies just internal to or overlapping the excretory canals; from its outer side a narrow, lightly coiled tube leads to the base of the cirrus pouch which it enters. It runs on the dorsal side of the excretory canals. The cirrus pouches are long and relatively thick saccular organs lying transversely near the anterior margins of the segments. In the early stages of development, the cirrus pouches on each side lie to the inner side of the excretory canals, but they soon pass to their outer sides, which relation they then maintain to the end of the chain. They are about 630μ long and 110μ broad, and open into small chambers which in turn open in distinct pores situated on the lateral borders, not far from the anterior lateral angles. The cirri are often seen partly extruded through these pores, and they are relatively thick and straight, being of the same diameter for their whole length, with slightly rounded tips. They are about 460μ long and 45μ in cross section, and their outer surfaces are thickly covered from base to tip with small straight spines set perpendicular to the surface and about 7μ long. These organs are the same in appearance and have the same relations with the other organs on both sides of each segment (fig. 2).

Ovary. The paired ovaries are large and are situated one on each side of the mid-line, about mid-way between the anterior and posterior borders of the segments. Each consists of four or five lobes, which radiate forwards and laterally from a central point; the small compact vitellarium lies close behind them. The distances of the ovaries from one another, and consequently from the lateral

borders on the corresponding sides, vary slightly in different segments. The shell gland, as a rule, is not clear, but in some segments it can be seen lying between the ovary and vitelline glands (fig. 2).

Receptaculum and vagina. The vagina is a relatively wide tube; running from the ovary it first curves forwards and outwards, then turns and runs directly outwards, and crossing ventral to the seminal vesicle, but dorsal to the nerve and excretory canals, it finally runs ventral to the cirrus pouch to open at the genital pore on the ventral side of this organ. The final part of its course can only be determined in sections.

Uterus. The uterus is visible at an early stage as a thin transverse tube crossing the proglottis almost from one side to the other, about mid-way between the anterior and posterior borders of the segment (fig. 2). As it develops, it throws out numerous branches in every direction, which gradually increase in size, so that eventually the uterus appears as a broad saccular organ occupying nearly the whole of the segment, with a few trabeculae representing

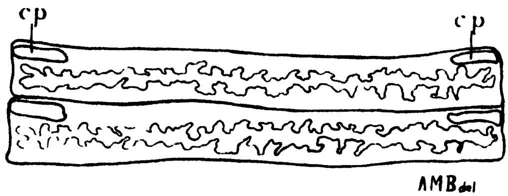

FIG. 5. *C. oligorchis*, n. sp. Uterus in intermediate stage of development. *c.p.*, cirrus pouch. × 20.

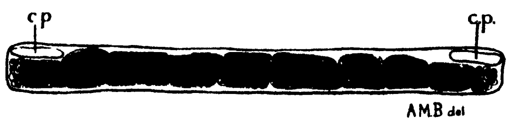

FIG. 6. *C. oligorchis*, n. sp. Fully developed uterus. *c.p.*, cirrus pouch. × 17·5.

the remains of the original branches (figs. 5 and 6). When the uterus is fully developed, the eggs lie singly in capsules.

In sections showing the early stages of the uterus, it is seen to pass between the testes (dorsal) and the ovaries (ventral), and at the sides it crosses the excretory canals dorsally and runs almost to the edge of the segments (fig. 3). Later, it pushes the canals ventrally, and tends somewhat to disturb the contour of the muscle layers

(fig. 4). No fully developed eggs were seen, the most mature ones measured about 43μ and the oncosphere 26μ in diameter.

DIAGNOSIS.

Up to the present, ten species of the genus *Cotugnia* have been recorded (Meggitt, 1920). All except *C. browni*, Smith, possess numerous testes. *C. browni* has six to seven testes, but these lie anterior to the female glands. The present species possesses only from three to five testes on each side, and these lie posterior to the female glands; it is thus obviously new, and is accordingly named *Cotugnia oligorchis* on account of the few testes.

The type specimens are in the museum of the Liverpool School of Tropical Medicine.

NOTE.—*Diploposthe laevis*, Bloch, was first recorded in Australia by Krefft under the name *Taenia tuberculata*; this material was re-examined by Johnston (1912), who assigned it to the above species. The host, in this case, was *Aythya australis*, Gould, the White-eyed Duck or Widgeon. Later on, Johnston (1913) recorded the same cestode in Queensland; this time the host was *Dendrocygna arcuata*, Cuvier, and his specimens came from the Australian Institute of Tropical Medicine. The writer, on examining the slide of this cestode, placed in the Institute museum by Johnston, found that beyond doubt it is a worm of the above described species with two ovaries, and is not *D. laevis*. Therefore the record by Johnston of *D. laevis* in the host *D. arcuata* is not correct. However, *D. laevis* does exist in Queensland, for the writer has recently examined some material at the Australian Institute which proved to be *D. laevis*; these worms were taken from *A. australis*, the original host in which Krefft found it in New South Wales.

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NOTES ON AUSTRALIAN CESTODES

BY

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AND

T. SOUTHWELL

(*Received for publication* 10 *February*, 1922)

IV. *GYROCOELIA AUSTRALIENSIS*, Johnston

This cestode is evidently fairly common, as it was found in the intestines of several members of the species Spur-winged Plover (*Lobivanellus lobatus*, Lath.) shot in the neighbourhood of Townsville, North Queensland.

EXTERNAL ANATOMY.

Fixed worms measured 167 mm. in length, with a maximum breadth of 4 mm.

The worm is very narrow anteriorly, and widens fairly rapidly and evenly posteriorly. The most striking character is its dorso-ventral diameter, which is very great, especially towards the posterior end. The segments are thick in the centre and thin at the edges, so that in cross section they are bi-convex. The large regularly alternating cirrus, extruded in most mature segments, can be easily made out with the naked eye.

Head. The scolex is flat anteriorly, and measures 0·315 mm. in breadth and 0·22 mm. in length. From the centre of the anterior surface arises a thin rostellum about 120μ long and 40μ broad, tapering anteriorly and ending in a bluntly rounded tip; there is very little muscle in this organ. Unfortunately, in all our specimens the hooks had been lost. The four suckers are placed, two on the dorsal and two on the ventral surface of the scolex, and look directly dorsally and ventrally respectively. They are circular in outline, and measure about 130μ in diameter. Behind the scolex there is no true neck, but a short unsegmented portion of about the same width (fig. 1).

Segments. Segmentation begins at a distance of 4·8 mm. from the anterior end, and about the first ten segments become successively narrower, thus giving rise to the appearance of a neck. The minimum breadth is about 170μ; from this point the segments progressively increase in width to the posterior extremity.

The dimensions of mature segments are 1·25 mm. across the anterior, and 1·5 mm. across the posterior borders, with a length of 0·8 mm. It is thus apparent that the posterior angles are slightly projecting (figs. 2 and 3).

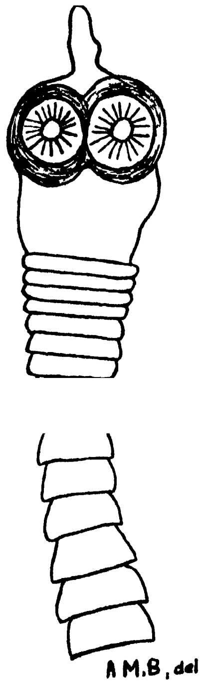

FIG. 1. *G. australiensis.* Scolex and anterior portion of strobila. × 56.

INTERNAL ANATOMY.

Muscular system. In transverse sections the relatively great thickness of the cestode is seen to be due chiefly to the longitudinal muscle fibres, which are arranged in two distinct layers (fig. 4). From without inwards the structures are arranged as follows. First there is the cuticle, which is about 90μ thick, then a layer of transverse muscle, and next to it the outer layer of longitudinal

muscle. This measures about 60μ in thickness, and is composed of oval, discrete bundles of muscle fibre lying with the long axis of the bundles dorso ventral. On the inner surface of this layer is another thin band of transverse muscle, which has on its inner surface the

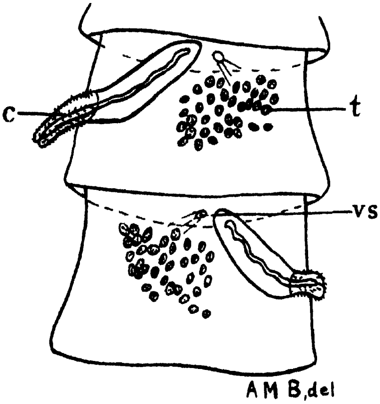

Fig 2 *G. australiensis* Young segments showing male genitalia. *c*, cirrus, *t*, testes, *v s*, vesicula seminalis. × 35

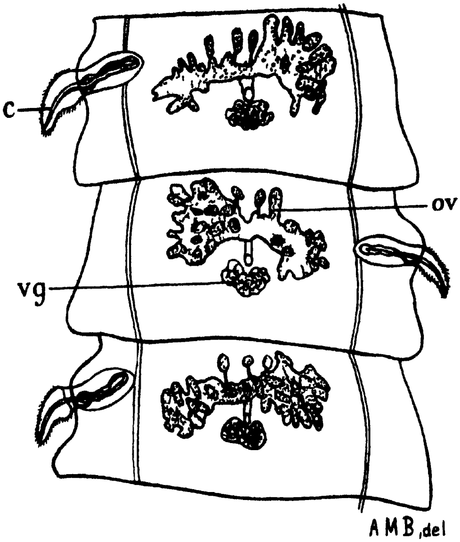

Fig 3 *G australiensis* Older segments showing female genitalia *c*, cirrus, *ov*, ovary, *v.g.*, vitelline glands × 35.

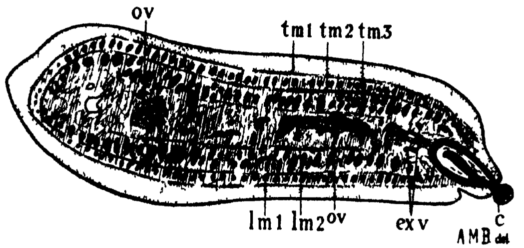

Fig. 4. *G. australiensis*. Transverse section of mature segment. *c*, cirrus; *ex.v.*, excretory vessels; *l.m* 1, outer layer of longitudinal muscle; *l m* 2, inner layer of longitudinal muscle; *ov.*, ovary; *t m.*1, outer layer of transverse muscle, *t m.*2, middle layer of transverse muscle; *t m.*3, inner layer of transverse muscle. × 20.

second and thicker layer of longitudinal muscle. The dorso-ventral diameter is about 140μ in the mid-line, and gradually decreases towards the sides; like the outer layer it is composed of oval bundles of fibres, but in many cases these are broken up into smaller

subsidiary bundles. Dorso-ventral fibres can be made out running between the bundles of longitudinal muscle. On the inner side of the second layer of longitudinal muscle are a few scattered transverse fibres, and these with the two outer layers of the same fibres end in the outer coat of the cirrus pouch where this organ is present.

Nervous system. The main longitudinal nerve is situated well to the outer side of the ventral vessel, and ventral to the cirrus pouch. Further details of this system were not investigated.

Excretory system. The dorsal-lateral excretory vessel is smaller in diameter than the ventral, and lies directly dorsal and close to it, except when the cirrus pouch passes between them, where they become more widely separated.

Testes. The testes are found only in young worms in which there is no trace of the female genitalia, even in the terminal segments. They first appear about the thirtieth segment, and from this point posteriorly they gradually become more developed, and again dwindle, until at about the hundredth segment they have quite disappeared. The testes number about fifty in full development, and measure 45μ on an average. They occupy the central portion of the proglottides (fig. 2).

Vas deferens. The vasa efferentia appear to unite in a small globular structure, evidently a vesicula seminalis, which lies in the anterior of each proglottis, near the middle of the segments and just at the mesial end of the cirrus pouch. They are in no instance conspicuous, and do not appear to function for storing the spermatozoa, except in the earliest stages; as the cirrus develops, the vesicula atrophies and finally disappears. That portion of the vas deferens within the cirrus pouch becomes increasingly coiled as the seminal vesicle atrophies, and it appears to take on the functions of the latter.

Cirrus pouch. The cirrus pouch is a relatively large, thick-walled sac, lying diagonally across the antero-lateral angle of the segments on the pore side, and it opens with absolutely regular alternation on the lateral borders of the segments, slightly in front of the middle. It measures about 450μ long and 150μ broad, and as the worm is at this time only about 1 mm. broad, it is a conspicuous organ. It persists in older worms after the testes are gone and the female glands are well developed; but at this stage

then either put her unwashed hands to her mouth, or wipe them in a handkerchief which she subsequently used to wipe her face. She never manifested any symptoms.

The Medical Officer of Health, Kingston, has vaccinated more than five hundred contacts, and he states that no cases of alastrim have occurred amongst them. I have vaccinated twenty contacts, and these were also completely protected.

On the other hand, five cases occurred in vaccinated infants, three in infants two years old, and two in infants four years old.

Goldsmith and Loughnan (1921) give clinical notes of three cases occurring in the vaccinated, three years, one and a half years and one year after successful vaccination.

Re-vaccination after alastrim.

Sixty cases were vaccinated by me during convalescence, the time of vaccination varying from the fifteenth day after the onset of the rash up to the twelfth week.

Of these, fifteen showed no sign of 'take' in two weeks, but twelve of these fifteen were subsequently vaccinated with three 'takes.' The method used was that of simple incision through the surface layers of the skin. Of the forty-five 'takes' none was typical as compared with normal controls vaccinated with the same batches of lymph.

Course. The incision healed over, and no sign of 'take' was visible before the seventh or eighth day, when a few papules were seen in the line of the incision. The papules increased but slowly in size, and by the fourteenth day were raised about 2 mm. above the surface of the arm. No induration or swelling of the arm was noticed, and in only a few cases was there adenitis, temperature, malaise or an areola more extensive than $\frac{1}{2}$-c.m. around the lesion, and even in these few cases the symptoms were hardly noticed. On pricking the early vesicles a small quantity of clear fluid was obtained. The lesion was multilocular, and on removing the top of the vesicles in a few cases it was seen that the base was composed of exuberant granulations rising up above the level of the skin, accounting for the fact that sometimes on pricking a small amount of blood came out with the fluid.

The scabs fell off in four weeks or more, and with one exception the resulting scar was not the depressed, pitted scar of typical

vaccinia, but on the contrary slightly raised (hypertrophy) above the surface, subsequently contracting to the level of the surface.

The points of difference between this and typical vaccinia appear to be:—

1. Tardy development and course of lesion.
2. Small size of vesicles and exuberant base and imperfect umbilication.
3. Insignificance of both local and constitutional reaction.
4. Resultant scar.

The evidence of the nature of vaccination after alastrim seem to show that vaccine lymph contains something else beside the factor which protects against alastrim, and it is this something else which gives the reaction after alastrim. The vaccine lymph on examination was found to contain a large amount of *Staphylococcus aureus*, an organism which is present in many specimens of calf lymph, and it may be this organism which causes the reaction, but the lesion produced did not suggest a septic process.

I inoculated four rabbits with the fluid from the vaccine lesion of one of the post alastrim cases, but the results were negative.

My opinion is that alastrim and vaccinia belong to the same group but present slight individual differences, the one disease affording almost complete immunity to the other.

IV. MORBID ANATOMY

CASE 1. Post-mortem performed 16 hours after death. Death took place on the 12th day of disease. Patient thickly covered with rash, which was confluent in parts and presented inequality of size of vesicles. Small petechial haemorrhage was seen on the sides of the abdomen. Patient was 6 months pregnant. She was admitted bleeding from nose, mouth, uterus. The mouth and throat were filled with a mass of necrotic material, and the entrance to the larynx and the vocal cords was similarly covered with necrotic material. The trachea contained pocks in its entire length. The right lung showed a haemorrhagic condition. There was a broncho-pneumonia with small spots of scattered haemorrhage visible on the cut surface of the lung. The left lung was apparently affected in the same manner, but to a less extent. The heart showed petechial haemorrhages under the epicardium, especially at the root of the aorta, and gross haemorrhage into the muscle substance of the left ventricle. Valves normal. The kidneys presented gross haemorrhage in the medulla and the pelvis was filled with blood. The bladder also showed haemorrhage under the mucous membrane, especially around the outlet. The liver was enlarged, but to the naked eye not obviously abnormal. Spleen not enlarged, firm. Stomach filled with 'coffee grounds' material,

petechiae present under mucous membrane. Intestines: colour dark red, with much haemorrhage and oedema. This condition affected the duodenum and first 3 feet of the jejunum. No lesion seen in the foetus.

CASE 2. Post-mortem six hours after death. Patient well covered with rash, which, on the face, was beginning to crust. Some confluence present on left side of abdomen. Patient 7 months pregnant. The throat was filled with necrotic material as also was the entrance to the larynx. Trachea showed the presence of pocks in its entire extent, and a similar condition obtained in the bronchi. Right lung showed some small haemorrhages and broncho-pneumonia. Left lung apparently normal. No haemorrhage into pleura or pericardium. Heart: A few spots of haemorrhage over the right ventricle under the epicardium. No gross haemorrhage into the substance of the muscle. Valves normal. Liver much enlarged and fatty. Spleen normal. Kidneys normal in size, but pale and fatty. Capsule stripped easily. No gross haemorrhage seen. Bladder normal. Uterus: A large subperitoneal haemorrhage on the right side just below the fallopian tube. Uterus contained a 7 months' foetus, which, on examination, showed a few subepicardial haemorrhages. Stomach normal. Intestines: The first 2 feet of the jejunum presented a remarkable condition; they were dark, haemorrhagic, and very oedematous. The whole lumen was in parts a solid mass.

CASE 3. Death on 11th day of rash. Scabbing on face and in upper part of chest. There were areas on the arms, abdomen, and particularly on the legs, in which absorption of the fluid in the vesicles was taking place leaving the vesicles lax. There were also large areas of confluent eruption about the size of half-a-crown on the outer portion of both legs, and on the sides of the abdomen. Some of the fluid from these areas was blood-stained. On other parts of the skin where the rash had been confluent the epidermis was stripping off leaving the surface raw. A putrid odour was observed. The trachea had small, ulcerated lesions extending down to the bronchi. The lungs were apparently normal except for a small portion of the upper lobe of the right lung. This appeared to be consolidated. Heart firmly contracted with somewhat excessive fat under the epicardium, otherwise normal. Aorta: Some athero-sclerosis. Liver large, somewhat congested, and on section looked like a nutmeg liver. Spleen smaller than normal, firm and fibrous. Kidney normal in size. Capsule stripped easily, substance rather pale, vessels more prominent than normal. Suprarenals normal. Bladder normal. Uterus: 2 small subserous fibroids. Intestines normal, but filled with a very large amount of faeces, especially the sigmoid and rectum.

CASE 4. Infant born with scabbing eruption; died 4 days after birth. General appearance normal save for eruption. Mouth, larynx, trachea normal. Lungs presented an unusual appearance; they were reddish-brown in colour, and on the surface was scattered small, white areas about 2 mm. in diameter. These areas extended for a short distance into the surface of the lung. The lungs were partially solid. Liver was dark red in colour and presented an appearance similar to that of the lung. Spleen apparently normal. Kidneys: There were small haemorrhages under the capsules and extending into the cortex. Suprarenals normal. Heart and circulatory system normal.

CASE 5. Infant born with alastrim. Mouth showed rash on the inside of the cheek. Larynx and trachea normal. Lungs and liver: condition similar to those of Case 4. Spleen and other organs normal.

Inoculations. Fluid was collected from the skin lesions of patients in various stages of the disease, and twenty-six rabbits and

four calves were inoculated by Professor MacCallum and myself. The skin was shaved and scarified, in some cases drawing blood, and the material was well rubbed in. These all gave negative results.

Blood from early cases and from a few patients who after contact with cases had developed headache and fever, but none of whom subsequently had an alastrim rash, was also used, but with negative results.

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GOLDSMITH and LOUGHNAN (1921). *Journ. R.A.M.C.*, Vol. XXXVI, p. 66.

EXPLANATION OF PLATE III

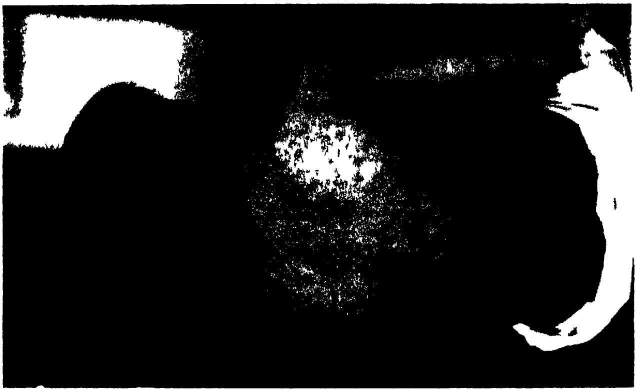
Severe case. Patient vaccinated twelfth day after exposure to infection. Rash developed on eighteenth day and ran concurrently with vaccination. Some of the lesions show secondary umbilication due to resorption of fluid.

PLATE III

C. Tinling & Co., Ltd., Imp.

EXPLANATION OF PLATE IV

Showing distribution of rash in a moderate case.



C. Tinling & Co , Ltd., Imp.

EXPLANATION OF PLATE V

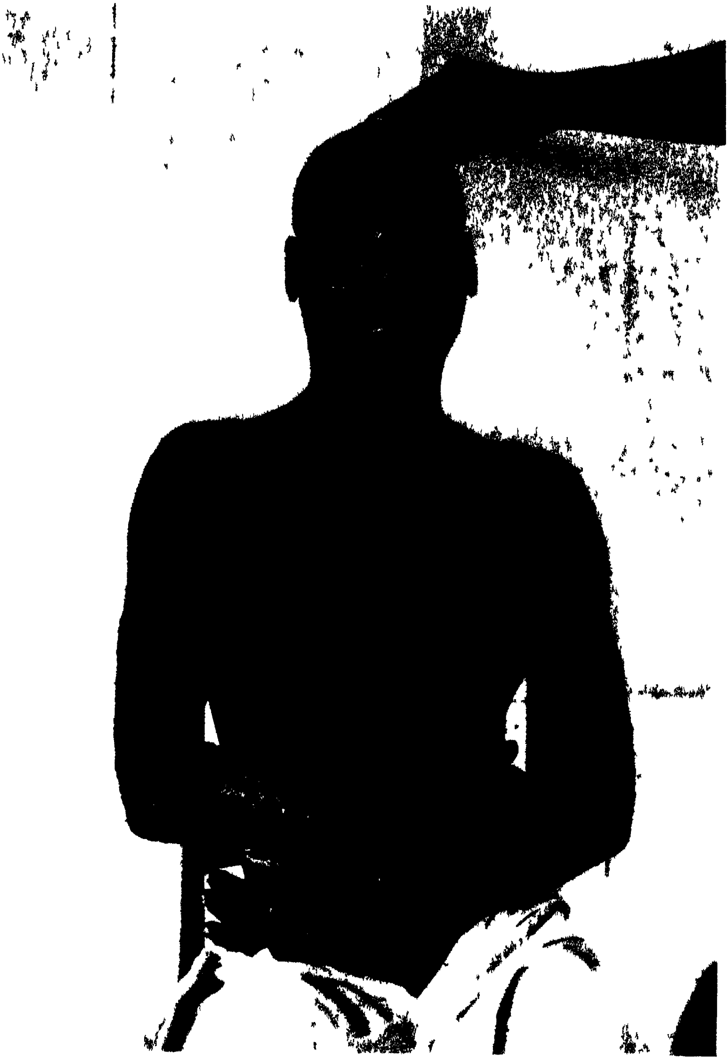
Showing effect of irritation. Note patches on inner side of left thigh above knee. This crop came out around a septic cut.

PLATE V

C. Tinling & Co., Ltd., Imp

EXPLANATION OF PLATE VI

Eighth day of rash. Left eye almost closed.



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EXPLANATION OF PLATE VII

Child born at full term with well developed rash. Mother vaccinated one month previous to birth of child. No history of illness in mother. Wassermann reactions of mother and child negative.

C. Tinling & Co., Ltd., Imp.

A NEW SPECIES OF *PHLEBOTOMUS* FROM TRINIDAD

BY

Prof. R. NEWSTEAD, F.R.S.

(*Received for publication* 23 *January*, 1922)

Phlebotomus trinidadensis, sp. n.

A relatively small species. ♂ genital armature with five large spines to the superior claspers: three terminal or distal, and two slightly beyond the middle distance, arranged with their bases on opposite sides of the segment; no tufts of non-deciduous hairs, proximally.

Colour of both sexes similar. Pale ochraceous. Wings with the costa sometimes distinctly infuscated, and in certain lights with intense iridescent blue. Legs silvery grey.

Male. Abdominal hairs of the medio-dorsal line arranged in small, sparse groups on all of the segments; those of the venter dense, some of them semi-erect, others procumbent. Hairs of the proximal segments of the superior claspers very long and dense. *Palpi* of five segments: second, third, and fourth equal in length; the third and fourth broadened distally; fifth, two and a half times longer than the fourth. *Antennae* with the third segment projecting slightly beyond the tip of the proboscis; geniculated spines relatively very small, and apparently bilateral, those on the third about one-eighth of the entire length of the segment; those on the sixth and seventh a little less than one-fourth the entire length of the segments respectively. *Wings* (fig. 1 *a*) moderately narrow, the fork of the fourth vein generally in advance of the proximal fork of the second. *Genital armature* (fig. 1 *b*), relatively large; superior claspers each with five long, stout spines: three distal and two slightly beyond the middle distance, the latter arranged with their bases on opposite sides of the segment, the two outer, distal ones and the inner,

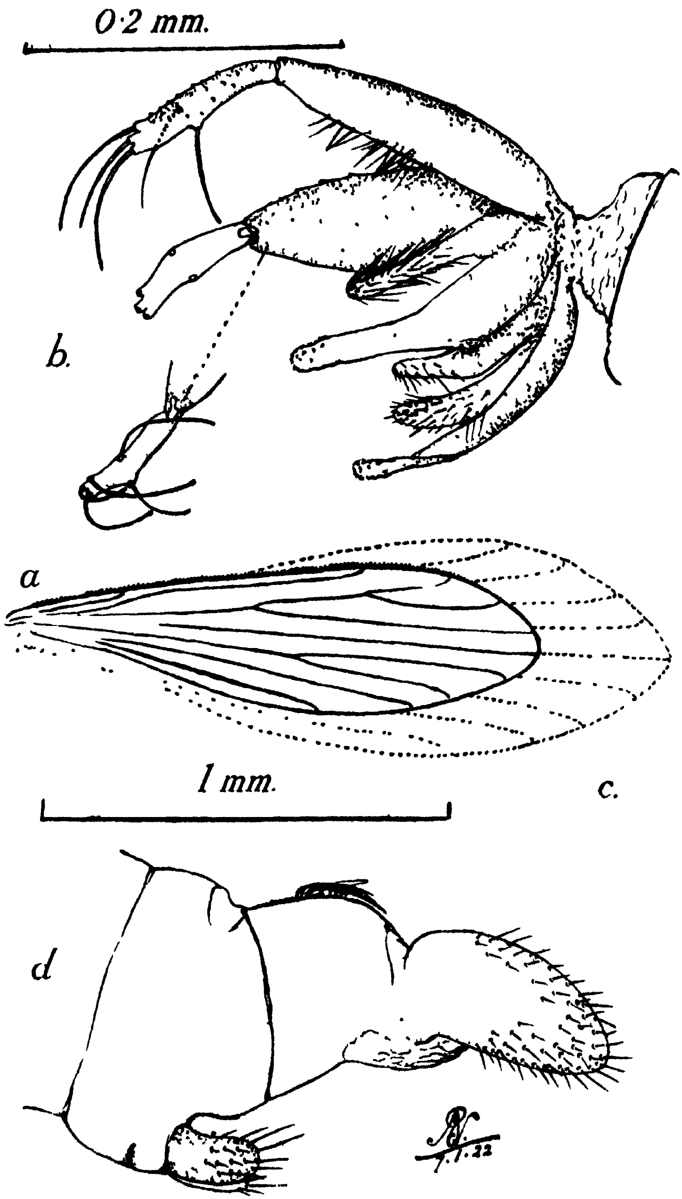

Fig. 1. *Phlebotomus trinidadensis*, sp. n.

♂ : *a*, wing ; *b*, genital armature. ♀ : *c*, wing ; *d*, terminal segments with the paired leaf-like appendages. *a*, *c* and *d* to same magnification.

the worms are about 2 mm. broad, and as the cirrus pouch does not increase above the dimensions given previously, its size in relation to that of the proglottides is not so great.

The cirrus is nearly always extruded; it measures about 400μ long and 90μ thick at the base. In the early stages it is a long, fairly thick tubular structure, slowly tapering from base to bluntly rounded tip. Its external surface is thickly covered with backward-curving spines about 4μ long (fig. 2). It runs posteriorly as a rule, and in many cases is recurved, so that the tip points towards the lateral border of the same or the succeeding segment. In worms in which the female genitalia are developed, the cirrus is generally stouter and more conical in shape, and it tapers much more rapidly (fig. 3).

Ovary. The ovaries are only found in older worms. They first appear about the seventy-fifth segment, and have reached full development by about the ninety-fifth segment. In these worms the seventy odd small segments in front of the one in which the ovary is first seen are devoid of all traces of genitalia, either male or female. Apparently therefore, in attaining a certain age, the worms lose their power of developing reproductive organs, any further segments being sterile.

Fully developed ovaries are about 700μ broad and consist of two lobes each composed of lobules running for the most part laterally. The two lobes are united across the mid-line by an isthmus, they are unequal in size, the one on the cirrus side being only about half the size of the one on the opposite side. The result is that they present a regularly alternating asymmetry (fig. 3). In addition, there are three or four small masses of ovarian tissue lying anterior to the isthmus of the gland, and more or less directly connected with it. The ovaries lie across the centre of the proglottides about mid-way between the anterior and posterior borders.

Receptaculum and vagina. Both these structures are absent.

Vitelline glands. The vitelline glands consist of a small horseshoe-shaped mass of tissue, with the concavity facing forwards. They lie in the mid-line behind the ovaries and towards the posterior margin of the segments; ducts can be seen running forwards from their concavities, and these have the follicles of small shell glands grouped around them.

Uterus. The uterus first appears as an oval tubular ring nearly completely surrounding the ovary and vitellarium, which rapidly atrophy (fig. 5). Outpocketings soon appear on the tubular uterus (fig. 6). They become progressively larger and more complicated as development proceeds, until the ring-like structure is nearly lost, and in full development the uterus is represented by a large lobulated sac occupying almost the whole of the proglottides, both laterally and antero-posteriorly (fig. 7).

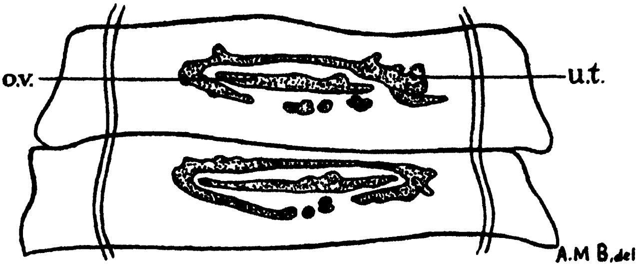

FIG. 5. *G. australiensis.* Segments showing first stage of uterus. *ov.*, ovary undergoing atrophy; *ut.*, uterus. × 35.

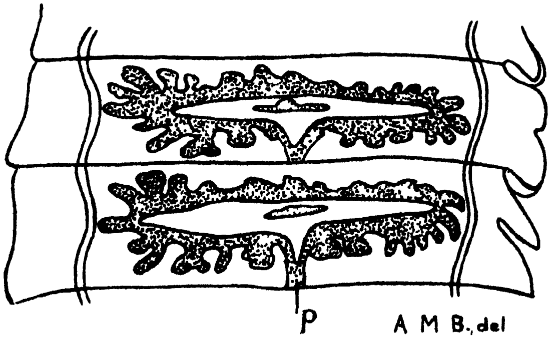

FIG. 6. *G. australiensis.* Segment showing uterus more fully developed. *p.*, uterine pore. × 35.

Another remarkable development is that of uterine pores; these open externally on the centres of the posterior borders of the segments, one on the dorsal and the other on the ventral surface. From examination of horizontal sections, we are of the opinion that these pores arise from a single central opening on the posterior of the uterus, from which two canals run, one to each pore (figs. 6 and 7).

Eggs. The eggs are slightly oval with blunt extremities. They measure about 65μ long and 52μ broad, and the contained embryo, which is enveloped in an albuminous covering, is also oval, and measures about 36μ by 26μ. The hooks on the embryo are about 16μ long.

Fig. 7

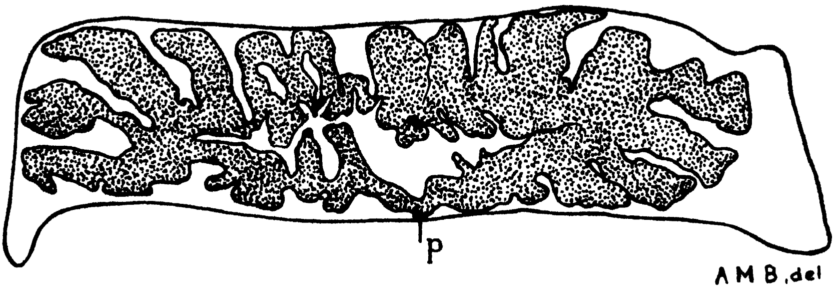

FIG. 7. *G. australiensis.* Fully developed uterus. *p.*, uterine pore. × 35.

DIAGNOSIS.

Although the hooks had been lost from our specimens there seems no reason to doubt that the worm is *Gyrocoelia australiensis*, Johnston. It is, however, necessary to point out that Johnston (1912) figures five minute testes lying immediately anterior to the ovary. Our specimens present a similar appearance, but these structures seem to us to be detached ovarian acini. Further, Johnston (1914) recorded a *Gyrocoelia* sp. from *L. lobatus*, which worm he obtained from the Australian Tropical Institute, the same source as our material, so it is practically certain his unnamed species is also *G. australiensis*.

Clausen (1915), in his description of *G. paradoxa* (von Linstow) (= *Brochocephalus paradoxus*), figures a bi-lobed or double receptaculum seminis enclosed in the uterine ring. Our specimens present a somewhat similar appearance, but the structure is obviously the degenerate ovary and vitellarium.

The occurrence, in our worm, of the male and female sexual organs at different times, which results in a strobila being male when young and female when middle aged, raises the point as to whether

this condition does not likewise exist in the genus *Dioicocestus*, Führm., 1900, in which case its characters would be limited to the possession of double male genitalia, and an irregularly alternating vagina.

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A CONTRIBUTION TO THE KNOWLEDGE OF THE BIONOMICS OF SAND-FLIES

BY

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PLATE VIII

During the late campaign in Macedonia, members of the B.E.F., Salonika, suffered more or less continuously during the hot season from sand-fly bites and sand-fly fever. As seems to be always the case, the trouble was very definitely localised, the usual foci being either dilapidated villages in or near which units were stationed, or entrenched positions which had been long occupied. In the summer of 1918 there was a severe outbreak of the fever in and round Janes (where in one unit from mid-June to mid-August there was an incidence of 150 per cent. of the total strength), and I was instructed in the third week of June to investigate the conditions as regards sand-fly in the district. Owing to an attack of dysentery I was unable to proceed to Janes until the second week in August, when much valuable time had unavoidably been lost. The following pages reproduce almost verbatim a report on my investigations between August 12th and September 26th based on copious notes made on the spot. There have been incorporated also various observations made during 1917-1919 on *Phlebotomus* in Macedonia.

It may not be irrelevant to mention in passing that on my way to Salonika in July, 1917, I kept a constant lookout for *Phlebotomus* wherever the frequent stoppages of a troop train offered an opportunity of searching any likely spot. A species of the genus (probably *papatasii*) was first encountered at a small station near Beaune (Côte d'Or), and other examples were noted later at Orange (Vaucluse). At the time I was not prepared to find the genus so far north, but Major Joyeux has subsequently told me that during the war special search was made for *Phlebotomus* in France, with the result that *P. papatasii* was met with amongst other places near Beaune and as far north as Paris itself.

In Macedonia the species of sand-fly (*Phlebotomus*) investigated

were three in number, viz., *P. papatasii*, Scop.; *P. minutus*, Rnd., and *P. perniciosus*, Newst., the first named occurring, at Janes, in by far the greatest numbers. Owing to the difficulty of discriminating between the females of these insects no attempt was made to determine specifically all the material collected, but in some hundreds of cases in which identification was effected *P. minutus* formed about 1 per cent. and *P. perniciosus* 2 to 3 per cent. of the total. Probably one is safe in saying that 95 per cent. of the sand-flies observed belonged to *P. papatasii*. Melanic forms of all three species were observed and in long series of *papatasii* many colour variations were noted, but the proportion of these to the total was not worked out. Really dark examples were, however, uncommon. From various sources it appears that by the date on which observations were commenced sand-flies were much less common than earlier in the season (June). Nevertheless, up to September 10th they were numerous wherever sought for, and in certain localities very abundant. Between the 10th and the 14th of the month there was a great falling off in the numbers found daily, but even so a good many could be taken up to the end of the month, and these later captures were still persistent in their attacks.

In connection with the association together and seasonal prevalence of these sand-flies, it is interesting to note that in 1917 (August to September) I did not certainly meet with *P. minutus*, while *P. papatasii* and *P. perniciosus* (though one or other occurred in numbers at Kalamaria, Salonika, Karasouli, Lahana, Nigoslav) were never taken together. In the present season, 1918 up to June 24th, only *perniciosus* occurred sparingly at Kalamaria. Again between July 24th and August 10th *perniciosus* (with one or two *minutus* latterly) was so abundant in the same place that in a single evening (9 to 11 p.m.) two hundred could be taken at light in one latrine. *P. papatasii*, though carefully sought for, was not detected. Newstead, in describing *perniciosus*, records a similar experience in Malta. 'Two examples of *P. minutus* were found in association with this species, but strange as it may seem, not a single example of *P. papatasii* was either captured or seen on these occasions.'

In 1917 sand-flies (*P. perniciosus*) were still common at Karasouli in the third week of October.

As to the part played by these three species respectively in carrying sand-fly fever in Macedonia, little evidence is to hand. Assuming that all are potential vectors, it is by no means certain that each carries the fever in proportion to its numbers. In any case *P. minutus* seems hardly likely to be of much importance in this rôle. As regards *papatasii* and *perniciosus*, the former is in my experience not only more active but more voracious and incessant in its attacks. In three localities where sand-fly fever was reported (Karasouli, 1917; Salonika, Janes, 1918) it was present in numbers, and in two instances was the only sand-fly taken. My present impression is that *perniciosus* is if anything a less efficient vector than *papatasii*, but the point is one which can be settled only by direct experiment.

The work done at Janes has included the following:—(*a*) A search for the early stages of sand-flies *in situ*. (*b*) A study of the habitats and habits of the imago. (*c*) Breeding and rearing of the flies. (*d*) Preventive measures.

A. SEARCH FOR THE EARLY STAGES

During the whole of my stay at Janes search has been made more or less continuously for ova, larvae, or pupae of sand-flies. In the first three weeks practically nothing else was attempted, but the result of protracted examination has been negative. Search has been made (1) in the soil itself to a depth of 6 inches, particularly near any indication of moisture, (2) along the sides of earth cracks and fissures so far as they could be followed; (3) beneath loose stones and in the superficial layer of cracked rock at or near outcrops; (4) between sandbags and loose earthy rubbish thrown up in erecting tents, marquees, etc.; (5) between mud bricks or masonry in the lower tiers of buildings; (6) in the dampest looking recesses of dug-outs and among débris beneath hay stacks.

This failure to find any early stages is parallel to the experience of many other investigators, and does not necessarily imply that search was made in wrong directions. Subsequent experience of ova and larvae from captive females indicated that the earth, etc., previously examined was much too dry, and that larvae, if they were to be found, should have occurred at greater depths. It is

possible, however, that larvae are absent or much less plentiful while the adults are numerous. Newstead, who worked in Malta in July, August and the first week of September was under the impression that larvae would be more numerous in autumn about a week after the adult had disappeared. As has already been stated, sand-flies began to decline in numbers at Janes between the 10th and 14th of September, and it was on the 20th that I found newly-hatched larvae for the first time in my breeding-boxes (see below, App. III, No. 1).

B. HABITATS AND HABITS OF FLIES

Habitats. (1) In mid-August, and for some time afterwards, sand-flies occurred practically everywhere in and near the C.C.S. They were more numerous, however, in tents and wards. In dug-outs they were comparatively scarce, which was at first rather surprising since at the same time one had a report that up the line the flies swarmed in dug-outs. The explanation appeared to be simply that the flies gathered as near as possible to their hosts. The hospital dug-outs were unoccupied, while the others were regularly used. In the same way where two wards, one occupied the other empty, adjoined, the former yielded many more flies than the latter. Again in a ward which, as sometimes happened, had only a corner bed occupied, the flies were most numerous in that corner. In large marquees or wards the distribution of the flies varied from day to day and with the hour of the day. After a windy night few could be found, and those that occurred were in sheltered corners. They were most abundant after still, damp nights. In the morning one found them mainly beneath the flaps running round the top of the sides of the tent, and the flies so taken showed a large percentage of newly-fed, gorged females. Later in the day, from roughly 11 or 12 a.m. to about 2 p.m., the flies became temporarily scarcer, while during the afternoon they were more frequently seen in numbers on the lower half of the side, males being numerous and often predominating. Pairs *in cop.* were common in the morning. Where the sides of marquees, closed during the night, were left standing by day more flies were found. Invariably, too, where the sides were rolled up into a corner, flies

were found within the roll. When the ground at the corner was cracked, flies were observed emerging from the earth and entering the folds of the roll, so that even after clearing such a roll in the forenoon one might later in the day take many flies from the same place.

(2) Earth cracks, in fact, proved to be effective day-shelters for *Phlebotomus*. The most important proved to be those occurring on the exposed surface of the soil where it had been dug out to make a level floor for tentage. The presence of flies in the cracks was easily demonstrated by blowing tobacco smoke or by squirting into the lower portion a little paraffin or even plain water. Within a tent twelve to fifteen flies might thus be driven from a crack less than a foot long and a few inches deep (August); when so expelled the flies generally came back after a short flight, and they had to be pretty thoroughly disturbed before they would travel any distance. Sometimes when driven from one crack they merely hopped along the cut surface and entered another.

(3) Sandbags employed to raise the level of the sides of tents, etc., are also a fertile source of trouble. The flies rest not only in the crevices between the sacks, but also enter the loose earth inside through the interstices of the coarse sacking. Where dug-outs are near wards, and their entrance is reinforced with sand bags, many flies will be found. In the tent which I occupied during my stay at Janes were several courses of sandbags. The following experiment was many times verified. When one opened up the tent and allowed strong light to fall so that one side of the person was illuminated and the other side in the shade, as one stood with the hand extended towards the sandbags, then though no flies had previously been noticed, bites began to be received in a very short time. After one or two such trials it was possible to see the sand-flies emerging from their retreat to the attack, which was always made on the shaded side. Besides the situation indicated, sand-flies shelter by day in hanging clothes, cupboards, blankets, beneath pillows, etc.

Habits. In studying the habits of *Phlebotomus*, much difficulty was at first experienced in keeping the flies alive. In test-tubes many died within two days, and few survived the third day. Not even when the air was kept humid could oviposition be induced.

In the end, suitable apparatus for handling the flies was improvised, and a list is appended.

Various devices for keeping the flies alive were tried during the first four weeks, and ultimately earthenware pots for single or smaller lots and cages for larger numbers proved most useful (see Appendix I). In the earthen pots—which were first suggested to me by Lieut.-Col. C. M. Wenyon—single specimens were easily kept and handled as follows. The fly was caught in a test-tube over the end of which a piece of cotton was loosely tied so as to form a small bag. The test-tube was then inserted through the sleeve of the cover. A little water was next poured into the pot and the cover tied on, the test-tube being fixed at any desired height above the water by a piece of string passed round the sleeve (fig. 4). Flies so kept showed an interesting periodic movement, staying all day in the cool, humid air below and appearing at the top of the tube during darkness. They were generally restless—particularly *papatasii*—about dusk. In cages provided with a tray filled with moist earth, stones, etc., a similar movement was observable, the flies hiding in crannies by day and emerging by night. A considerable proportion, however, remained by day crowded together in corners of the cage. They were frequently observed drinking from the wet earth.

In collecting sand-flies a pot was taken and covered and the flies introduced into the sleeve from the test-tube in which they had been caught. The sleeve was then tied and the pot stood in a bowl of water (fig. 5). To feed them it was necessary, first, to turn the flies loose for a time into a fly-proof box fitted with a sleeve to admit the arm (fig. 3). It was noticeable that flies kept in solitary confinement would seldom feed if the tubes were merely inverted over the arm.

In pots, unfed, a variable proportion of the flies—up to 50 per cent.—lived a week, 2 to 3 per cent. lived nine days, one ♀ (out of a batch of six hundred) lived exceptionally thirteen days. No ♂ was observed to live more than eight days under these conditions. All the females that lived nine days or over were examined as to the condition of their ovaries, and were found to be spent or practically so. In no instance could they be induced to feed in this state, though offered repeated opportunities—in the case of the last extending over the eleventh, twelfth and thirteenth days.

(1) *Biting, etc.* No males were detected in this act. The large number of this sex found with the females (as compared with *Culicidae*, where often the total catch from a ward will not include a single ♂) seems to be due to the fact that mating takes place after the female has had a blood feed. In all the couples examined the female had recently gorged herself. While feeding *Phlebotomus* is easily disturbed, the slightest movement of the skin being sufficient to put the fly to flight. It is thus difficult to study the process of biting in detail. The insect settles, pitches forward slightly, thrusting the somewhat stout rostrum downwards while the palpi (maxillary) diverge a little. I have not seen more than about one-third of the rostrum enter the skin, and the labium does not buckle up as in *Anopheles* when engaged in the same act. Only the labella are flattened out above and behind the piercing part of the associated organs. The wings are meanwhile poised ready for instant flight. Blood can be seen in the sucking stomach within sixty seconds. A full feed on an empty stomach occupies from four to four and a half minutes, at the end of which the fly suddenly withdraws the rostrum and makes off. For about forty-eight hours after a meal blood can be seen in the 'sucking stomach' over-lying the mid-gut (whose contents are brown or blackish) on the left side, and the whole gut may be cleared in five days, but the process generally takes longer. The females will feed at two-day intervals (possibly at shorter periods), taking less copious feeds, but attempts to find how many feeds could intervene before the completion of oviposition were abandoned. The digested blood is passed out ultimately in the form of small, dark, sticky drops; one or two specimens when captured had the stomach gorged with pale fluid and the gut hardly darker.

(2) *Movements.* In cracks and on rough earth *Phlebotomus* ordinarily proceeds by short runs varied by jumping to one side or another; on smooth walls or fabric more by jumping and short flights. Confined in a test-tube the males commonly mount in seeking an outlet. Females, if recently fed, on the other hand settle downwards, but after the gut has cleared and the eggs laid they behave much as do the males. When first introduced into a cage or confined space sand-flies make determined efforts to escape. They pass through astonishingly small openings, using the proboscis

apparently as a lever and emerging sometimes with a considerable proportion of the scales and hairs missing.

(3) *Drinking.* As *Phlebotomus* runs over the surface of a piece of earth it may sometimes be observed to plunge the rostrum into the earth. If there is moisture present the fly may remain for some time still. To observe what was happening, specimens were isolated in plaster of paris cells and watched under a Zeiss binocular. After they had been imprisoned for twelve hours the block was placed in clear water, which at once mounted to the floor and sides of the chamber containing the flies. Practically all the insects commenced to drink, some of them running about excitedly for an instant before settling. As was noted before, the tip of the rostrum (labrum, epipharynx and hypopharynx, etc.) was thrust distinctly into the plaster, and the labellae, flattened out, closely appressed to the porous surface. The short superiorly ensheathing maxillae generally moved backwards and forwards for a short time in front of the clypeus, and the maxillary palpi—rather widely divergent, nearly at right angles to one another—moved tremulously. But during drinking the mouth parts were still. Swelling of the abdomen could be traced as the drink proceeded. Flies, both sexes, were found to drink readily in this way about twice daily. They were tried with drops of fresh human blood on paper slipped into the cell, but without result. This can hardly be regarded as conclusive, as the blood dried rapidly. Defribrinated diluted blood was next allowed to soak into the cell containing flies, but did not prove specially attractive. The flies appeared to be able to extract only diluted serum—the corpuscular débris being retained by the plaster. In the same plaster cells cut deeper *Anopheles* was also induced to drink water.

C. BREEDING AND REARING OF FLIES

(1) *Oviposition.* While the conditions in pots standing in water were congenial to the adult flies, there was apparently insufficient moisture within the pot to induce egg laying. Nor did females kept in a tube over moist paper oviposit. Complete success was, however, attained by the following methods. A thick 'tray' was partly filled with fragments of earth over which was lightly

sprinkled some crushed faeces of lizard, rabbit or man. The tray was then soaked in water and placed in a pot into which water had been poured to a depth of a quarter of an inch (fig. 5). The flies were then put in through the sleeve as usual, and the pot stood in water. After an interval the pot was opened; on washing out with as small a quantity of water as possible (20 c.c. was sufficient as a rule) a number of eggs were got from the sides. They were collected as follows. The liquid was centrifuged and the clear part used to rinse the pot again. This was done three times. Finally the sediment containing the ova was pipetted off and the ova themselves separated out under the microscope. The percentage of fertile eggs was extremely high, and their viability was not appreciably affected by their being for some time in water.

Besides the ova taken from the sides of the pot many were to be noted on the tray or among the earth, etc. To recover eggs so laid was an extremely tedious process. Some were picked up with a brush by direct observation, others recovered after carefully washing the contents of the trays. An improvement in gathering ova from the sides of the pot was effected by lining the inside with a single piece of cotton pressed down to fit exactly. The pot was then loaded as before. The eggs (which are at first pale and then darker like those of mosquitoes) showed up well against the cotton which was cut into strips and so passed below the microscope. A further advantage was that the cloth showed definitely the average position of the eggs laid on the sides of the pot to be along a band about three-quarters of an inch above the water surface (fig. 5, *o.*) This seems to indicate that there is a fairly precise optimum as regards moisture for oviposition. Eggs on the sides of the pot occurred singly, but the majority were found below the earth close to one another in bunches. The females had crawled into the smallest crevice possible and appeared to have projected the eggs still further. Beside all the larger collections of eggs in these cracks the mother could be found within two millimetres. She lay, as a rule, flattened between the surface of the tray and the overlying earth, with sometimes one or two eggs between the extremity of the abdomen and the rest of her laying. Sometimes an egg was seen attached to the terminal bristles of the genital appendages, and once or twice females had died with the egg between these appendages or blocking the genital

atrium. With a little care, it was easy to clear the earth from round each dead female and count the eggs laid. The larger batches contained from twenty-seven to thirty-four eggs. Sand-flies are not prolific insects, and the total ovarian content in *P. papatasii* runs from forty to fifty eggs. Assuming that these females had previously deposited one or two isolated ova on the sides of the pot, the proportion of eggs actually laid to the total possible is a high one. In some hundreds so secured there were practically none that failed to hatch. This high fertility and the large number of eggs laid may reasonably be held to indicate that natural conditions for oviposition had been secured.

Newstead, who in 1910 watched egg laying of *P. papatasii* in Malta, states (*a*) that the egg is projected some distance from the abdomen of the female; (*b*) that the process is so exhausting that the female may die after it; (*c*) that most of the eggs were laid *below* the moist blotting paper supplied to induce oviposition. With these notes the foregoing observations are quite in harmony, and it seems probable that the violent ejection of the ova serves to insert them into crannies where the abdomen of the mother cannot penetrate. Newstead saw the ova thrown about three times the length of the female abdomen, and this again agrees closely with the distance noted by myself.

In cages where the earth, etc., was placed on a shallow tray no excessive moisture ran up the sides (the water being completely absorbed), with the result that eggs occurred, so far as could be seen, only in pockets with dead females close by.

An attempt to determine whether the sand-flies in ovipositing showed any preference for one kind of faeces was inconclusive, owing to the development of microfungi, whose ramified mycelia enmeshed the eggs so that a complete count was impossible. The fungus growth was slight on lizard faeces either by themselves or mixed with earth, but very abundant on human faeces. So far as one could judge, however, plain earth or earth and lizard faeces held more eggs after some hundreds of females had been allowed to oviposit on plaster trays giving a choice of several kinds of larval food.

No female was noted to oviposit till four or five days after capture, and the eggs did not hatch till at least nine days more. The incubation period probably varies seasonally and specifically.

Ova belonging to at least two species were secured. Of these, one, the larger, was by its size, abundance, texture and resulting larva plainly *P. papatasii*. The other (probably *P. perniciosus*) was shorter and a little stouter. Apart from size, the two could easily be told towards the end of the period of incubation by two dark parallel lines which appeared shining through the shell laterally in each. In *papatasii* the lines at the caudal end of the ovum were rather broader and tapered towards the head. They could also be traced round the head and back towards the tail for a short distance. In the second species the calibre of the lines altered little between tail and head, and they extended nearly half-way back towards the tail on the other side. After hatching, these lines could be recognised as the caudal bristles, which are relatively short in *papatasii*. All through the first instar there is a kink in the caudal bristles, indefinite and near the extremity in *papatasii*, and much more decided and further back in the second species. The kink is, of course, at the point where the bristle is bent within the egg.

For the health and ultimate hatching of the egg a considerable degree of moisture is necessary—rather less, however, than is required to induce oviposition. Excess of moisture for a limited time has no effect on the viability of the eggs, for they may remain immersed a day or over and yet hatch. Eggs resting on earth surrounded by a thin film of water for three to four days also hatched. Drying, on the other hand, even a short time is fatal. A batch of eggs exposed in the shade overnight shrivelled before 11 a.m. next day, while in the daytime a few hours brought about the same result. (Time, 20th-25th September.)

(2) *Larvae.* When the egg is about to hatch the caudal bristles may be seen to move. There is a rippling movement also of the body from the tail towards the head on which, high up, almost vertical in position, is the well-developed dark egg tooth. Dehiscence of the shell is affected by a cut extending sometimes to half the length ventrally (?) and backwards for a short distance dorsally (?). The eyeless and legless maggot emerges slowly, and is at first entirely pale save for the egg tooth and bristles. The head, however, darkens in a few hours. In emerging the larva seems to be coming from two valves, but in some cases the line of

dehiscence is cut laterally as well as dorso-ventrally so that a relatively large oval piece of chitin falls from one side of the shell. Excessive moisture retards the process of hatching, always a slow one, and when the surface on which the egg rests has a thin covering film of water the larva may be found barely clear of the shell twenty-four hours after hatching began.

The newly hatched larva is sluggish, and, indeed, during the whole of this instar little activity is shown. It lies either flat on the supporting surface with the caudal bristles extended in the same line, or resting on the ventral caudal third to one-half of the abdomen, with the rest of the body raised and the last segment with its bristles slightly upturned. In this pose the larva is U-shaped. In a modification of this attitude the head is again thrown forward and the whole creature in profile S-shaped. The larva's progress is undulating. The head is first raised and the anterior segments stretched forward. The mandibles now press (or grip ?) firmly some inequality of the surface, and with this purchase the body is dragged slowly forward. Folds in the skin, and possibly the peculiar hairs of the body, aid in the process.

The tiny larvae begin to feed almost as soon as the head has darkened, *i.e.*, the mandibles are hardened. In feeding on lizard faeces they select the rough portion consisting of chitinous fragments mixed with partially digested fibre, and reject the more homogeneous limy part. Three individuals watched settled down respectively to the mandible of an ant, the head capsule of some small hymenopteron and the leg of a beetle, and ate the half-digested muscle fibre inside these structures. In the same way they enter and feed on the dead bodies of the parent flies. Older specimens of the first instar will also attack and devour larvae immediately after hatching.

Fungus was so troublesome (being rightly or wrongly blamed for the loss of many young larvae) that some substitute food was sought. Finely ground mixed blood and earth has proved satisfactory for this purpose. It is spread in lines on shallow plaster trays with the eggs near, and the whole covered with rough pieces of earth. The young larvae feed readily and appear to thrive, and no fungus has as yet developed.

Larvae in the first instar can survive excess of moisture for some

time. They sink readily in water, and are not sustained for any length of time by the surface film. When dried after lying twenty-four hours on wet soil they are lethargic but soon recover, yet like ova they are extremely sensitive to thorough drying and shrivel if exposed a few hours in the shade.

The first ovum to hatch did so on 20th September, and the first example in the second instar was seen on 26th September. In this stage the egg tooth has, of course, gone; the caudal bristles have increased from two to four, with a dark chitinous saddle connecting them. There is also a considerable increase in size.

In India, according to Howlett, there are separate broods of *P. papatasii* in August and September, while the wintering brood begins in late October or early November. At Janes I have seen no trace of the September brood, and the slow growth of these larvae hatched from late September eggs suggests that in Macedonia there may be one less brood than in India, and that the wintering brood commences here at least a month earlier.

Subsequent experience confirmed my expectation that the September hatched brood would hibernate. It was impossible to give much time to observing the larvae during the last week of September and the first fortnight of October, owing first to the congestion of the C.C.S. after the push, and later to the severe epidemic of influenza. But about the middle of October a considerable number of larvae, mostly in the second instar, were successfully taken to the Base and installed in the laboratory at 52 General Hospital. They were by this time very sluggish, and, in spite of being kept in moistened earth in a room which was heated at least during the daytime, latterly ceased to feed, while some died. One lot which had been left as it came from Janes was allowed inadvertently to dry up completely. On examining this tray in the third week of November (by which time it must have been quite dry for a month) I could find no larvae moving on the surface, but on breaking up the earth as a precautionary measure before throwing out the contents of the tray, I found several larvae in little pockets or blisters in the earth. They lay quite straight out but appeared stout and contracted, the integument wrinkled slightly towards head and tail, the gut empty or practically so. The only movement exhibited was a slight twitching from side to side of the extremities

when the animal was gently touched. By bringing larvae in this condition into moist, warm surroundings it was possible to revive them so that they recommenced to feed. Unfortunately the few experimented with were accidently destroyed.

The bulk of my larvae had not revived naturally at the end of March, 1919, and the attempt to bring them to London failed. While it is not suggested here that *Phlebotomus* hibernates naturally under such conditions as have just been described (the opposite, indeed, is much more likely), it is evident that these larvae, once the critical stages of hatching and the first instar have been overcome, have unexpected powers of resisting dessication which must be of considerable help to the species in its natural breeding haunts in cracks, etc., where the conditions as regards moisture are variable.

D. PREVENTIVE MEASURES

(1) *Nets.* During my stay I used the sand-fly net issued to the troops with satisfactory results. With a flash-light at night one could see the flies settling on the net, yet none were noted to pass through. Once or twice sand flies (up to four) were found within the net in the morning, but these, I believe, came not from the outside but from blankets or below pillows, having got there during the process of bed-making. They also find harbour inside sleeping bags, and all bedding should be thoroughly shaken or beaten just before the net is adjusted for the night.

In this connection, however, it is worth recording that of thirty to forty mixed sand-flies placed in a small bag of the material from which the nets are made and hung up loosely, all escaped within half an hour. The flies behaved as they do when confined in a cage, pushing in all directions to find an outlet. I have found in the same way that a certain number of mosquitoes in a brood covered over with ordinary netting will manage to struggle through. The species in which this was noted were *Culex pipiens*, *Anopheles palestinensis* and *A. bifurcatus*. In spite of this the net in use appears to be efficient, though possibly where *P. minutus* preponderates a finer material might be necessary.

(2) *Repellents.* (*a*) Ordinary *Paraffin* is, if liberally applied, effective in keeping off the flies. It might be used as a stop-gap. M.T.C. drivers reported that they had employed it with good results, but I do not regard its regular use as advisable, and made no tests personally of the time for which an application remains effective. (*b*) *Mosquito Pomade* and (*c*) *Paraquit* were both tried. The former was issued to various members of the personnel of the C.C.S., who reported favourably on its use. Of the two, Paraquit is perhaps more pleasant to use. Well rubbed in, I found it effective for about three hours when one was sitting still or not moving actively. I found it sufficient to rub the Paraquit into the back of the hand, wrist and halfway up the arm towards the elbow, the neck, ears and round the scalp, but not into the hair. For the bites themselves I found appreciable relief by dabbing on a little rectified spirit with cotton wool.

(3) *General.* The breeding-sites of *Phlebotomus* hitherto recorded have been varied. Larvae have been found in soil along the sides of the embedded portion of the lower corners of old masonry; in rubbish in cellars, in earth cracks, etc.—the common feature in each case being darkness, moisture, and the presence of organic débris. While it is possible that at 31 C.C.S. the flies came in part from farm buildings near by, I think it most probable that the main breeding-places were in or round the hospital itself, in the cracks where the adults were themselves found. There was nothing in the distribution of these adults to suggest that their breeding-sites were other than generally distributed. Where there were more flies there were more men sleeping. In such circumstances prophylactic measures are difficult to carry out, and the only remedies available are probably palliative rather than radical.

The following suggestions are given for the treatment of tents and marquees. The floor should be levelled and cracks filled up with a mixture of *cresol* and *sand* or *sawdust*. *Clay* is unsuitable, as it is apt to crack in turn (this was repeatedly noted) and the most minute fissure will harbour many flies. The floor should then be liberally watered with a strong solution of cresol, and if possible covered with a ground sheet. Periodically, according to the severity of the plague, the tent should be closed and sprayed with a solution of formalin or fumigated with cresol. 1 per cent.

formalin has been recommended for spraying, but I believe this is too weak. In corrugated iron huts a 1 per cent. mixture of cresol in paraffin emulsion might usefully replace formalin for spraying. Around the tent all cracks (to a breadth of two feet from the tent) to be filled up and the soil to be sprinkled to the same width with cresol.

In latrines where crude cresol was experimentally sprinkled round the drums, sand-flies were reduced in number for two to three days, and ceased to bite on the exposed legs though bites were still received on the neck. A similar reduction was noted in a store where cresol was regularly sprinkled.

As far as possible, shallow soil with frequent outcrops of loose friable rock should be avoided in choosing a camp site. Loose soil removed in pitching tents should not be allowed to remain in camp. Building up with sandbags round tents, etc., is to be deprecated. Spilling of water or any liquid containing organic matter should be carefully avoided. The appearance of cracks in the soil should be watched for and counteracted by filling up when possible and spraying with cresol when the cracks are more extensive. From ten to fourteen days after the disappearance of the successive waves of sand-flies that occur from June to September a thorough sprinkling of cresol over suspected breeding-sites is to be recommended.

I have to thank heartily Lieut.-Col. Ievers, D.S.O., O.C., the 31st C.C.S., for his kindness in affording facilities for work during my stay at Janes, and very specially Lieut.-Col. C. M. Wenyon, C.M.G., who first suggested the investigation.

In conclusion, I should like to record my indebtedness to Captain Beer and Corporal Gibson, R.E. (143 Field Company) for carrying out my design for the breeding-cage (fig. 1), and to Captain Morrell, Dental Officer to the C.C.S., who supplied the plaster trays and cells.

APPENDIX I

Apparatus used in Studying the Life History of *Phlebotomus* spp.

Cages may be made to suit requirements. (*a*) The following dimensions housed comfortably 600 sand-flies, 13 in. broad × 14 in. high × 6 in. deep, made of 1 in. wood, back of tin driven into the wood and nailed, on inside faced with cotton glued down and whitewashed. All joints glued and rabbeted. One or two panels of cotton fixed closely by strips of wood to afford ventilation. Tin tray to hold water in bottom. Flies admitted by tightly-corked circular opening at side. Front glazed to depth of about 10 in.—the glass set in putty. Narrow panel door below glass 12 in. × 2 in., made fly-proof by cloth edging. All round the door the joint is rabbeted and felt lined. The door may be

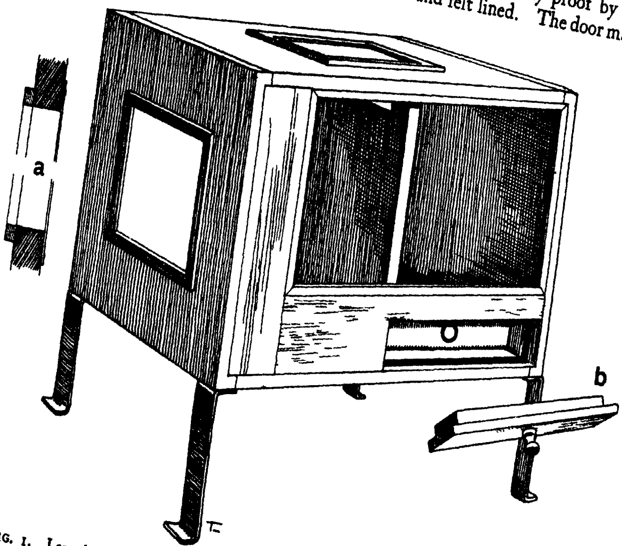


Fig. 1. Large breeding and feeding cage (11¼ in. × 15½ in. × 14¾ in.) front view. Glazed in front. *b*—Rabbet-fitting door giving access to tray for disposition of plaster receptacles of earth, etc, on which flies oviposit. The mid-partition cut down to give access of flies to host. *a*—Detail of ventilation showing the inner screen of stout wire-gauze and the outer cotton cloth.

secured by a clip. The middle surface of the rabbet pressing against the felt makes the joint fly-proof. (*b*) The above cage (no fig. given) is suitable when ova and larvae only are wanted. When the adult flies have to be fed for some time in numbers a more elaborate cage is required (figs. 1 and 2). It consists of two chambers. In the right-hand one the flies oviposit on material in tray. In the left chamber a rabbit or other small mammal can be accommodated for a time, but should not remain continuously with the flies. The animal sits on a wire grating and its urine and faeces are caught in a tray. Ventilation at top and side. In the latter

case the ventilator is double—cotton outside and strong wire-gauze towards the rabbit. Inside the door and fitted to the sides is a large sleeve through which the animal is introduced to the cage. In the middle the sleeve is held closed by an elastic belt to prevent the egress of the flies. The rabbit is introduced by forcing its head through the confined middle of the sleeve and sliding back the band over its body. The flies are put in as in cage (*a*) and gain access to their victim over and below the mid-partition, which is cut back for this purpose.

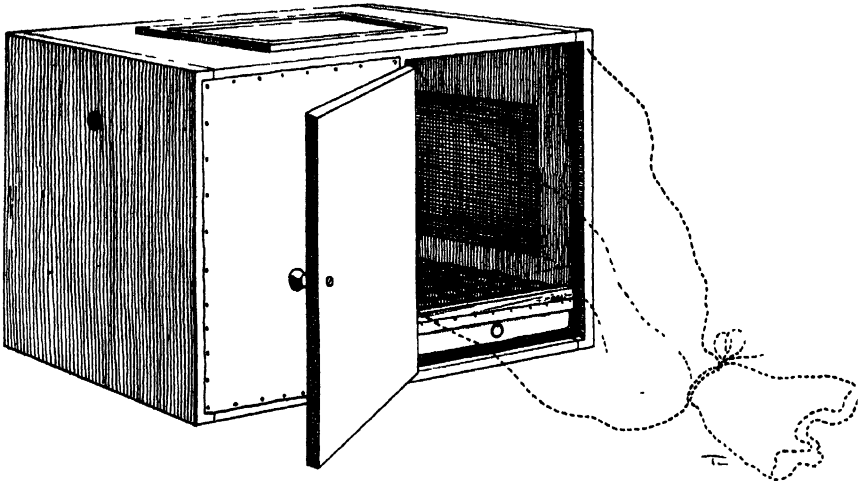


FIG. 2. The same from behind, showing the grid on which the rabbit is accommodated. Below, next to the door, is a wooden bar with a felt extension to make the faeces and urine tray fly-proof. The space above the grid is sleeved.

FEEDING CAGE. A quinine tin (10½ in. × 4½ in. × 6⅝ in.) with strong lever lid (fig. 3) was used for this purpose; the lid was cut out leaving only the rim and the reflexed edge. A row of holes about ⅛ in. apart was drilled along the latter and a sleeve sewn tightly on; a side was next cut away to ¼ in. from edge

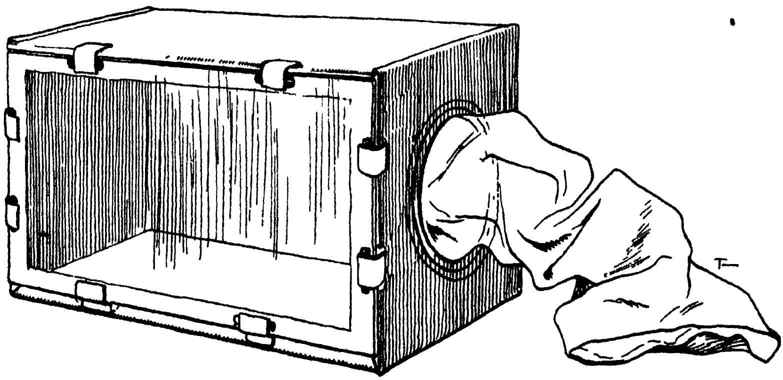


FIG. 3. Feeding cage with detachable sleeve.

and eight small clamps were soldered on, two at each side. The front was now glazed and puttied, and in the space between glass and clamps wedges of softish wood were fixed to prevent displacement of the glass. The inside of the cage was whitewashed. Flies kept in pots were released from their test-tube into the cage, fed, and easily recaptured.

The fact that no exact information was available in Macedonia as to the methods and apparatus used by previous workers was at first a considerable handicap. While it was easy to improvise ways of handling the flies in small numbers, many attempts were made before a satisfactory cage for dealing with large numbers of *Phlebotomus* was evolved. From the first cage made, 250-300 flies escaped in twelve hours, and only the closest search revealed the tiny escape hole. Some of the first boxes were constructed with grooved joints U, and the flies actually squeezed themselves round the U and so escaped. In other cases the flies disappeared gradually from the cage, but were not observed to escape. On taking the box to pieces they were found dead, packed solidly in the joints. Afterwards glued joints were tried with success. The superfluous glue must be carefully scraped off and the joint dusted e.g. with dry plaster of Paris to prevent the flies sticking. Glass jars are not suitable for housing *Phlebotomus* for any time, as the insects are liable to get stuck down by their wings.

In loading a pot with flies, the covers and tray are arranged as in fig. 5. The test-tube is then introduced into the sleeve perpendicularly, when the ♀♀ will generally drop down without trouble. The tube still in position is now laid

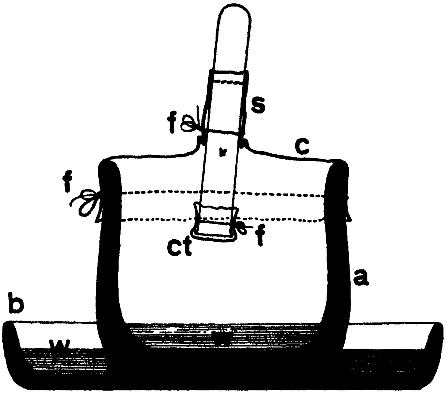


FIG. 4. Method of confining single flies required for observation. *a*—pot; *b*—outer tray; *w*—water; *c*—outer cover of pot with *s*—sleeve; *ct*—cover of test-tube; *f*—fastenings.

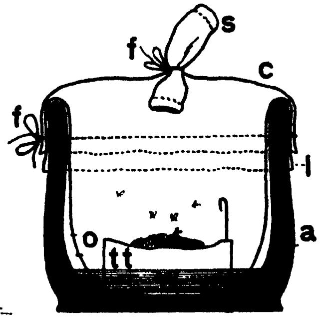


FIG. 5. *a*, *w*, *c*, *s* and *f* as in fig. 4; *l*—cotton lining of pot; *tt*—thick tray with faeces, etc.; *o*—approximate position of the zone on which most of the eggs not laid on the bait occurred.

horizontally for a moment and rapidly raised again to the first position. The ♂♂ come out, fly upwards, and are caught by the inner projection of the sleeve when the tube may be withdrawn.

The pot cover in fig. 5 is shown loose to prevent confusion with the inner lining, but in practice it must be tightly stretched and firmly secured, otherwise the flies squeeze down as far as they can get between the cover and the lining and are apt to be killed when the pot is lifted.

Cells and Trays of Plaster of Paris (fig. 6, *a-d*).

Cells. These were cast a little wider at the base than at the top. In shape square. Measurements at base $1\frac{3}{4}$ in., at top $1\frac{1}{2}$ in., depth $\frac{3}{4}$in. The corners and angles were bevelled off. On the upper surface a square ($\frac{1}{2}$ in. side) was cut to a depth of $\frac{3}{16}$ in., over this was laid a No. 1 $\frac{3}{4}$ in. cover-glass, and the surface gently scraped away round the central hole till the cover-glass slid easily backwards and forwards over the cavity.

Trays. (*a*) *Thin* for cages, oblong, 3 in. $\times$ $2\frac{1}{2}$ in. $\times$ $\frac{3}{8}$ in., with a central hollow about $1\frac{3}{4}$ in. in diameter sunk to about half the depth of the tray. (*b*) *Thick* for pots, circular, 2 in. diameter and $\frac{3}{4}$ in.—$\frac{7}{8}$ in. deep. At one side a small length of wire, bent to form a handle, was let into the mould to facilitate lifting the tray from the pot. The central hollow of these thick trays was made by a 2 in. watch glass.

Earthenware Pots of local manufacture, rough unglazed, circular, $3\frac{3}{4}$ in.—4 in. in diameter and about the same height, with an inside depth of 3 in.; average thickness of walls $\frac{1}{4}$ in. (see fig. 7, *a*, *b*). Covers for the above (fig. 7, *c*) were made of light, but closely-woven cotton cloth. In the centre was sewn a short sleeve of the same material. The sleeve was about $1\frac{1}{2}$ in. broad by $2\frac{1}{2}$ in. long above. It is an improvement to have it project below about $\frac{1}{2}$ in. to prevent the ready egress of the flies after they have been introduced into the pot.

Wooden cages are loaded through the circular aperture at the side, which can be kept closed by a cork. Flies, if thirsty, generally go easily into observation cells, but sometimes ♂♂ can be induced to enter only by inverting the cell above the mouth of the tube and catching the ascending *Phlebotomus*.

The thin, flat trays are useful for isolating any given set of ova or larvae which it is desirable to watch. Their containers should have some water.

All cages and pots should be insulated (e.g., by water) to prevent depredations by ants, etc.

The sketches have been made by Mr. Terzi from apparatus brought back by the author.

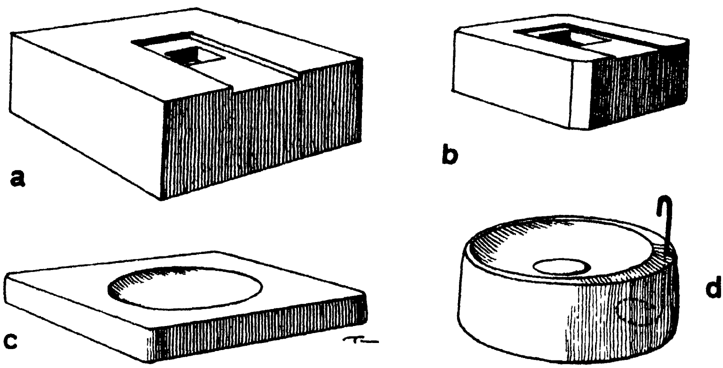


FIG. 6. *a*—large cell to demonstrate drinking habit of *Phlebotomus*, *b*—smaller block with larger well in which isolated ova were kept and development from day to day noted; *d* and *c*—thick and thin trays.

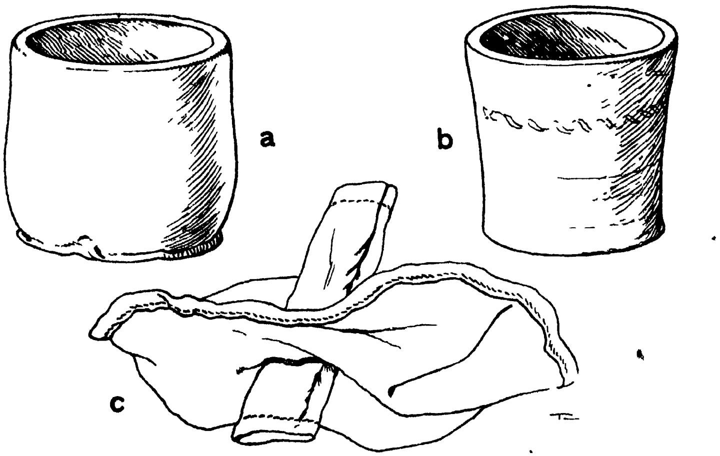


FIG. 7. *a* and *b*, Earthenware pots. *c*, Cover with sleeve.

APPENDIX II

Feeding of the Larvae of *Phlebotomus*

Faeces. Three kinds were used. To avoid any unpleasantness they were well dried and powdered before use, except in the case of the lizards' excreta, which were not offensive.

(*a*) *Lizards* (caught in some cases in cracks tenanted by sand-flies) were kept in a cage whose front and bottom were of coarse wire-gauze. The cage stood over a tray in which the faeces collected. The lizards were fed at first from fly-traps and on various insects specially caught for them. Latterly it was found that they would take grasshoppers readily, and as these *Orthoptera* made a more quickly satisfying meal and were easily secured, this became the staple ration for the lizards. The faeces were stored in test-tubes and did not generally develop fungus. Only the portion first passed, consisting of fragments of the exo-skeleton of insects to which some of the undigested internal parts still adhered, was of use. The more homogeneous urates—a limy-looking mass—were rejected.

(*b*) *Rabbit faeces*, well dried and crushed roughly.

(*c*) *Human faeces*, dried for twelve hours in oven and reduced to a very fine powder in a mortar.

Plain Earth. Dried at air temperature; small stones removed; powdered in mortar. Small larvae were observed to ingest this, doubtless for the sake of the associated bacteria, etc.

Earth and Blood. Earth prepared as above. Human blood haemolysed, but not defibrinated. The two were mixed to the consistency of a thin mud. Next dried in oven into a cake, which was reduced again to a powder and stored for use. This was a most excellent food for young larvae. They gathered about the lines where it was laid, and its passage into their gut could quickly be traced under the binocular.

NOTE ON TABLE (APPENDIX III)

From the middle of August to mid-September daily catches of *Phlebotomus* (up to 300 per day) were made at Janes. In all about 3,000 specimens were handled. Notes are given below on some of these lots so collected. Although I frequently watched *Phlebotomus* sucking blood, I do not think that a full feed was made on more than six or seven occasions, in all of which the times taken were very uniform, there having been not more than 15-20 seconds difference between any of them. A note on one such case is appended. No. 8.

APPENDIX III

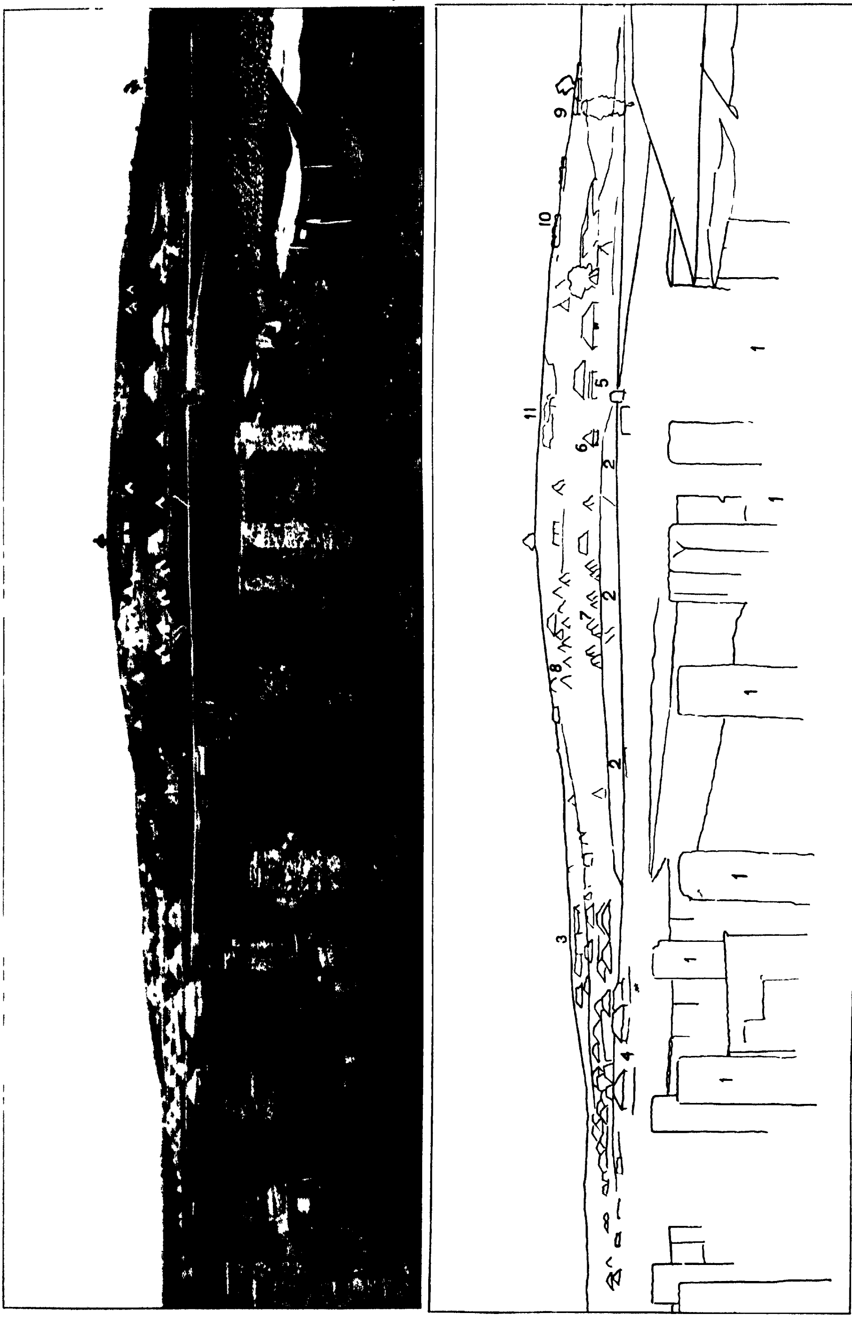
No. of experiment	No. of flies	Larval food	Results of experiment			Surviving unfed
1	50	4.ix.18 Confined over lizard faeces	12.ix.18 All dead save one pair: ♂ moribund—died in two hours; ♀ active, refused to feed, though given choice of two hosts, died in 12 hours; ova laid in pot	20.ix.18 Ova hatched	26.ix.18 Larva (1) noted in 2nd instar	♂ 8 days. ♀ 8¼ days
2	70	6.ix.18 Lizard faeces	16.ix.18 All dead. Ova laid, numerous, several batches, up to 34. Much mildew in faeces	20.ix.18 12 ova placed on blood and earth, all hatched	21.x.18 Many larvae hatched. Two spp. present	
3	100	7.ix.18 Broken rabbit faeces and earth	16.ix.18 All dead save one ♀; she will not feed; ova, several, enmeshed in mildew	18.ix.18 ♀ dead	21.x.18 Many larvae hatched. Two spp. present	♀ 11 days
4	120	8.ix.18 Human faeces on earth lump	18.ix.18 All dead, not many eggs		21.x.18 Many larvae hatched. Two spp. present	
5	6-700	8-10.ix.18 Lizard, human, rabbit faeces in long tray	11.ix.18 Many dead	19.ix.18 None alive, though yesterday a ♀ was active; eggs found below broken pieces of earth	26.ix.18 Tiny larvae found completely enclosed in pockets formed by the breaking down of earth during moistening	♀ 8-10 days
6	100	Human faeces and earth	23.ix.18 All dead. Many eggs, but few on earth where mildew was dense; eggs in zone on cloth			
7	100	13.ix.18 Earth only	24.ix.18 Only one ♀ alive, will not feed: ova very numerous	26.ix.18 ♀ died, has not fed		♀ 13 days
8	1 ♀	28.ix.18 Specimen caught feeding. Gorged in 4 mins. 25 secs. Confined in test-tube in jar	30.ix.18 Sucking stomach half empty	1.x.18 Meal now visible only in mid-gut, which is about half-full and dark	7.x.18 Died	REMARKS.—This specimen lived an hour or two over 9 days after feeding. Showed the usual night and day movements. Deposited faeces freely. 29.ix.—5.x.18

EXPLANATION OF PLATE VIII

General View of Janes—31st Casualty Clearing Station, September, 1918.

1. Courtyard, pillars, etc., of Janes Farm.
2. Low, much cracked escarpment at roadside.
3. Hospital,—Wards, Sisters, etc.
4. Stores.
5. Pathological laboratory, Workshop, and Sanitary Section.
6. Entomolcgical laboratory.
7. Personnel of C.C.S.
8. Officers.
9. Isolation wards.
10. Isolation wards,—Offices.
11. Personnel (N.C.O.'s).

The original centre of distribution may have been—1, where the flies were always numerous in cracks in the lower courses of the masonry. They were to be found also by day along 2; and men in 7 suffered severely. The largest catches were made at 9 and 10.



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HUMAN INTESTINAL PROTOZOA IN AMAZONAS

BY

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(*Received for publication* 6 *March*, 1922)

The following findings of intestinal protozoa in five hundred persons were obtained from faeces collected for helminthic examination. The cases were unselected so far as their state of health was concerned, and were leading more or less normal lives, but almost all were infected with ankylostomes, and some showed malarial parasites in the blood. The majority of the stools were formed, a few were liquid, but no blood was observed in any.

The troops were living in barracks in Manáos, but were drawn from various parts of the State of Amazonas. The children examined were from the schools, and from a girls' orphanage in Manáos, the majority being girls. Matthews and Smith (1918 b) found little difference between boys and girls with regard to *E. histolytica*, *E. coli*, and *L. intestinalis* infections.

METHODS

The faeces were collected in glass tubes having corks fitted with metal spoons. The tubes were distributed on one day and in the majority of cases collected during the following morning, instructions having been given that the specimen was to be taken on the morning of collection. Some specimens were not ready when due for collection and were collected later. All were examined within forty-eight hours of receipt.

One wet preparation in iodine (iodine 1, potass. iodide 2, water 100) was examined from each stool, but in cases where the diagnosis was in doubt further preparations were made.

One stool only was examined in each case so that only a fraction of the total infections are represented in the results.

The criteria employed in identifying the cysts were those described by Matthews (1918).

RESULTS

The following protozoal cysts were found :—*Entamoeba histolytica* (Schaudinn), *Entamoeba coli* (Lösch), *Lamblia* (*Giardia*) *intestinalis* (Lambl), *Chilomastix* (*Tetramitus*) *mesnili* (Wenyon), *Entamoeba nana* (Wenyon and O'Connor), and *Iodamoeba bütschlii* (Prowazek). *Trichomonas hominis* was not found in any of the five hundred cases, but three infectious were detected in diarrhoeic stools from hospital cases in Manáos.

The total figures are given in Table I.

TABLE I

	Federal Troops		Children of School Age	
	No.	Percentage	No.	Percentage
No. examined	251	...	249	...
E. histolytica. Above 10μ	45 } 69*	17·9 } 27·5	35 } 56†	14·0 } 22·5
Below 10μ	29	11·5	24	9·6
E. coli	97	38·6	92	36·9
L. intestinalis	21	8·3	35	14·0
C. mesnili	11	4·4	4 } In 144 cases	2·8 } In 144 cases
Blastocystis	121	48·2	53	36·1

* 5 cases infected with both large and small cysts.

† 3 cases infected with both large and small cysts.

Figures for *E. nana* were not obtained as the structure of the nuclei of the cysts is not usually visible in iodine, and fixed preparations were not always made where its presence was suspected. It was, however, ascertained to occur.

Mixed infections are shown in Table II.

TABLE II.

	Troops	Children
No. examined	251	249
E. histolytica + *E. coli*	31	21
E. histolytica + *E. coli* + *L. intestinalis*	1	2
E. histolytica + *E. coli* + *C. mesnili*	3	2
E. histolytica + *L. intestinalis*	4	6
E. histolytica + *C. mesnili*	2	0
E. coli + *L. intestinalis*	6	10
E. coli + *C. mesnili*	6	2

SMALL CYSTS OF *E. HISTOLYTICA*

Small cysts (below 10μ) of *E. histolytica* have been noted by James (1914), Woodcock and Penfold (1916), Wenyon and O'Connor (1917), Dobell and Jepps (1917), and others. A detailed account of them, and evidence of their differentiation from the larger cysts of *E. histolytica*, are given by Smith (1918 and 1919).

Most observers hold that these small cysts constitute a separate 'strain' of *E. histolytica*, but Woodcock and Penfold state that it is quite likely that this form is either a distinct species or distinct variety. Morphologically they are similar to the 'ordinary strain' of *E. histolytica*, except only in size, and it has been generally assumed that they belong to the same species. No work appears to have been published on their pathogenicity to animals. Dr. R. M. Gordon and I endeavoured to infect kittens with this small cyst without success, but as failure to infect controls with the large cyst also occurred, no conclusions could be drawn. As some doubt, therefore, exists regarding this so-called 'small strain' the findings of the two sizes have been recorded separately in Table I. In Table IV these figures are combined for comparison with the findings of other observers. Little difficulty was experienced in ascribing infections to their respective groups as very few cysts in the neighbourhood of 10μ were encountered. In eight cases cysts belonging to both 'strains' were present.

Table III has been compiled from a paper by Smith (1919) with the addition of the present series and shows the relative proportions of ' small ' and ' ordinary strains ' among the total *E. histolytica* infections. The figures for the two Manáos groups—troops and children—have been added together as the distribution of the two sizes is similar in each group. Attention is drawn by Smith to the small percentage of the ' small strain ' in persons who had not been out of England.

TABLE III.

Size of Cysts in *E. histolytica* Infections.

	England only	England and Abroad				Amazonas
	Matthews and Smith	Mackinnon	Mackinnon (1918)	Dobell and Jepps (1917)	Matthews and Smith	Present Series
	Non-dysenteric cases	Chronic dysenteric cases	Dysenteric and non-dysenteric cases	Dysenteric cases	Dysenteric cases	Troops and Children
Cases	98	56	209	200	306	125
Infections	99	59	225	215	325	133
' Ordinary ' %	85	64	47	65	66	60
' Small ' %	15	36	53	35	34	40

Table IV shows the findings of intestinal protozoa by various workers in different parts of the world. The figures represent percentages, and are all based on the results of one examination per case. The figures for *E. histolytica* include all ' strains ' above and below 10μ, excepting those for Queensland where, Dr. Maplestone informs me, no cysts below 10μ were found. In the latter instance the stools were three to fourteen days old when examined.

Professor Kofoid has kindly supplied me with the figures for the United States of America. He states that they are probably higher than normal in the population as they contain large numbers of foreign immigrants and negroes from Florida. Figures published by Kofoid, Kornhauser and Plate (1919) for overseas troops of the United States Army are somewhat higher than those for home service troops.

TABLE IV

	England				Malta	Egypt		Queensland	U.S.A.	Amazonas	
	(1918b)	Matthews and Smith (1918a)	(1918a)	(1919)	Bentham (1920)	Wenyon and O'Connor (1916)		Maplestone (1920)	Kofoid	Present Series	
	Children 0–12 years	Hospital Patients Adults and Children	Army Recruits	Male Asylum Patients 17–78 years	Maltese Garrison Troops	Native Prisoners	Native Cooks	All Ages. 1–80 years	Home Service Troops	Children of School Age	Troops
No. examined	548	450	1098	207	200	524	87	500	576	249	251
E. histolytica	1·8	1·5	5·6	9·7	27·5	13·7	11·5	4·6	3·9	22·5	27·5
E. coli	11·1	6·7	18·2	45·9	27·0*	48·6	20·7	26·4	14·1	36·9	38·6
E. nana	2·7	2·4	5·5	12·1	5·4*	0·0	0·0	0·0	29·3	+	+
I. butschlii	0·2	0·2	0·4	...	...	14·8	7·0	1·0		+	+
L. intestinalis	14·1	6·0	7·0	3·4	14·8*	0·6	7·0	11·8	6·4	14·0	8·3
C. mesnili	1·8	1·5	0·2	23·2	25·7*	0·2	1·1	2·2	2·2	2·8†	4·4
T. hominis	...	...	...	...	2·7*	0·0	1·1	...	0·2	0·0	0·0
Blastocystis	...	...	...	...	...	+	+	+	30·7	36·1†	48·2

* In 74 cases. † In 144 cases.

SUMMARY

Five hundred persons living in Manáos were examined for intestinal protozoa with the results tabulated above.

The percentage of *E. histolytica* cysts recorded was somewhat higher than those reported from other countries for which figures are available, excepting Malta.

I am indebted to Dr. H. W. Thomas for allowing me to make use of the material collected for hookworm examination for this investigation.

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A PARASITE RESEMBLING *PLASMODIUM FALCIPARUM* IN A CHIMPANZEE

BY

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AND

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PLATE IX

The following observations were made by us on a chimpanzee, *Anthropopithecus troglodytes*, at Freetown, Sierra Leone. The animal, according to the statement of the owner, had suffered from an attack of dysentery lasting from January 1st to January 16th, 1922. It was examined by us on the 11th and 12th of January, at which time it was passing blood, pus and mucus. The only organisms found in the faeces by microscopical examination were large numbers of *Blastocystis* resembling *Blastocystis hominis*; no bacteriological examination of the faeces was made; the cutaneous blood was examined, and no parasites were found. From January 16th to January 31st the animal was well. On January 31st and February 1st it refused food; its condition improved on the 2nd and 3rd, but the next day it became worse, and the owner handed it over to us. The chimpanzee was very thin, its hair was coming out and it was obviously ill; on February 5th it had an attack of diarrhoea; no blood was passed; *Strongyloides* larvae were present in large numbers in the faeces.

Malaria parasites were found in the blood on February 4th. They increased in number and the animal's condition became worse. On the 8th of February, in the afternoon, it was somnolent, and on the 9th it refused food and drink, lay motionless, was not easily

roused, and remained in any attitude in which it was placed without attempting to change it. At 8.30 a.m., after considerable retching, it vomited. As the animal's condition was grave and appeared to be associated with the increasing number of parasites in its blood, 5 grs. of quinine bisulphate in solution were administered orally at 10.30 a.m. From February 11th till 19th its condition improved; the number of parasites in the peripheral blood was reduced rapidly by the action of the quinine, but the blood was never free. On the 19th the blood was again heavily infected, more so than on any previous occasion; the animal was ill, but its condition was not as grave as it was on the 9th, and by the 21st its appetite returned and it began to recover without any quinine. On the 22nd the animal was lively and eating well, and the parasites in its peripheral blood were decreasing. On February 23rd, at 8.30 a.m., the animal appeared well and made a good meal. At noon the same day it was found lying in its cage in a condition of collapse and breathing with difficulty; it had vomited a large quantity of bile-stained material. Death occurred in half an hour.

Post-mortem examination. The immediate cause of death appeared to be innumerable small haemorrhages which were uniformly distributed over the whole surface of both lungs; these haemorrhages were very recent, and on examination proved to be caused by the presence of Strongyloid larvae. An account of the changes produced by the larvae and the sites in which they were found will be given in a future communication. The trachea contained a small quantity of regurgitated food, but this was not sufficient to cause obstruction. The vessels on the surface of the brain were dilated; there were no haemorrhages on the surface or in the substance of the brain; there was no meningitis. The spleen was not greatly enlarged; it was very dark in colour and somewhat harder than normal. The liver was dark and congested. The bone marrow was dark red. The kidneys and the heart appeared normal.

EXAMINATION OF SMEARS AND SECTIONS OF THE ORGANS

Brain. A few trophozoites and gametocytes were found; the capillaries were not blocked with parasites; pigment was present in small amount.

Spleen. Trophozoites and schizonts were found, but were not numerous; masses of pigment were present; there was considerable fibrosis.

Liver. This contained pigment in very large amount; it occurred in granules and in coarse masses; some of the smaller granules were found in the liver cells.

Bone marrow. Trophozoites and gametocytes were present, and coarse pigment was plentiful.

Blood. Trophozoites and gametocytes were present, but were not very numerous; very heavily pigmented leucocytes were common.

TYPES OF PARASITE FOUND IN THE BLOOD

1. Large amoeboid trophozoites resembling *P. vivax*, in pale enlarged red cells.

2. Large heavy looking trophozoites more or less band-shaped and equatorial, coarsely pigmented, resembling *P. malariae*.

3. Trophozoites resembling small rings of *P. falciparum*. The red corpuscles were not enlarged and retained their colour.

4. Gametocytes were found, indistinguishable from those of *P. falciparum*; they were never present in large numbers throughout the course of the disease.

No schizonts were found in the blood.

The *P. vivax* and *P. malariae* forms were scanty; they were found on the 4th and 5th of February, but were not seen subsequently. After the 5th of February the parasites seen were invariably of the *P. falciparum* type; they showed a certain amount of pleomorphism, but this was not more notable than in the case of the human parasite. The pleomorphism consisted in the appearance of slightly amoeboid and *tenue* forms. Crescents appeared in largest numbers on the 12th and 13th of February, but even then were not numerous; no exflagellating forms were found.

IDENTITY OF THE PARASITE

The few parasites of the *P. vivax* type corresponded to *P. inui*, Halberstaedter and Prowazek, 1907, in that the host cell was enlarged and pale, and did not present Schüffner's dots. As they and the *P. malariae* forms were not found in the blood on or after

the 6th February, the conclusions drawn from the experiments detailed below cannot be considered strictly applicable to them.

Reichenow (1920) records the discovery of parasites identical morphologically with *P. falciparum* in chimpanzees and gorillas. These parasites were always found by him in association with *P. vivax* and *P. malariae* forms. He concluded that anthropoid apes are as sure a source of danger to Europeans living in West Africa as are negroes.

The conclusion of Reichenow as to the identity of the parasite he found in gorillas and chimpanzees with the human parasite is interesting. The establishment of this identity would necessarily lead to important inferences. It would mean that anophelines which had fed on infected anthropoid apes could acquire salivary gland infection. Such anophelines, in parts remote from human habitation, would be capable of infecting any human being who came within their range. In this way they would constitute a permanent danger to persons employed in opening up new areas.

Reichenow's conclusion appears to us too far-reaching in view of the fact that it is based on morphological grounds only. If his conclusion is correct, it becomes difficult to understand why inoculations from human beings infected with malaria into chimpanzees should fail. The only successful inoculation of malaria from a human being into an animal is that performed by Mesnil and Roubaud (1920). These authors succeeded after several attempts in inducing a transient infection with *P. falciparum* in one of two chimpanzees. The incubation period was ten days, and the animal recovered spontaneously after another ten days. It is significant that in the two experiments using as vector *A. maculipennis* which had been infected from a case of *P. falciparum*, transmission to the chimpanzees failed entirely. This alone would suggest that *P. falciparum* is not easily transmissible to the chimpanzee, in view of the ease with which infective anophelines transmit *P. falciparum* to human beings in laboratory experiments. The failure of Mesnil and Roubaud to transmit malaria to chimpanzees by the bite of infected anophelines raises the question as to whether the *P. falciparum* forms observed by them in the chimpanzee were really due to the inoculation or were a relapse of the parasite which occurs naturally in the chimpanzee.

In order to determine whether the parasite resembling *P. falciparum* found by us in the chimpanzee was capable of infecting human beings, we performed the following experiments.

EXPERIMENTS WITH LABORATORY-BRED *A. COSTALIS*

Laboratory-bred *A. costalis* were allowed to feed on the chimpanzee on two successive nights. After a lapse of from four to fourteen days from the first feed, forty mosquitoes were dissected, and in no case was infection found either in the gut or salivary glands.

EXPERIMENTS WITH INJECTIONS OF INFECTED BLOOD

Two Europeans were given subcutaneous and intravenous injections of blood from the chimpanzee. The first subject had never had malaria, and had taken prophylactic doses of five grains of quinine bisulphate daily from January 10th to February 6th, 1922. The last dose was taken at 7 a.m. on February 6th. On February the 7th, at 5 p.m., he received subcutaneously 1 c.c. of the blood of the infected animal. An hour later slight nausea ensued, which lasted two hours. The local reaction was slight. On the 9th of February, at 10 a.m., the same subject received an injection of 0·4 c.c. of the animal's blood into his right median basilic vein. At this time the animal's infection was heavy, *i.e.*, four rings to the field (Obj. 1/12, Oc. 0, Leitz). Slight nausea followed a quarter of an hour after the injection, and lasted a few hours. The subject's blood was examined twice daily from the date of the first injection, but no parasites were found. During an observation period of twenty-eight days, no infection occurred. An interesting fact was observed, namely, that from the 12th to the 14th of February transient urticarial patches occurred, localised round the site of the first inoculation. These patches appeared and disappeared several times during the course of the day.

The second subject had previously suffered from malaria, and recently, within a year, from a *P. falciparum* infection, but had been free from relapse during the last six months. He was taking two grains of quinine bihydrochloride daily until the 7th February.

He received on February 19th, at 7 p.m., 1 c.c. of the animal's blood subcutaneously; at this time the animal's blood showed as many as nine rings to a field. No local or general reaction followed. On the 20th February, at 5 30 p.m., he received 0·2 c.c. of the animal's blood intravenously. Examination of the subject's blood before the first inoculation was negative, as were also subsequent examinations. No infection occurred during an observation period of seventeen days after the second inoculation.

The results of the above experiments lend themselves to two explanations, viz., that the parasite is *P. falciparum* which has lost its infectivity for man by passage through the chimpanzee, or that it belongs to a new species of the genus *Plasmodium*. In view of the limited number of experiments performed, we consider it premature at present to decide definitely between these two interpretations. Our experiments so far certainly do not confirm Reichenow's conclusion that chimpanzees as reservoirs of *P. falciparum* are a source of danger to Europeans in West Africa.

SUMMARY

A parasite morphologically indistinguishable from *P. falciparum* was found by us occurring naturally in a chimpanzee in Freetown, West Africa. This parasite appears to be the same as that described by Reichenow in chimpanzees and gorillas, and stated by him to be the human parasite.

Laboratory-bred *A. costalis* fed on this chimpanzee failed to become infected, but, as stated above, crescents were few and exflagellation was not observed.

We have failed to transmit the infection to two human subjects by subcutaneous and intravenous inoculation.

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EXPLANATION OF PLATE IX

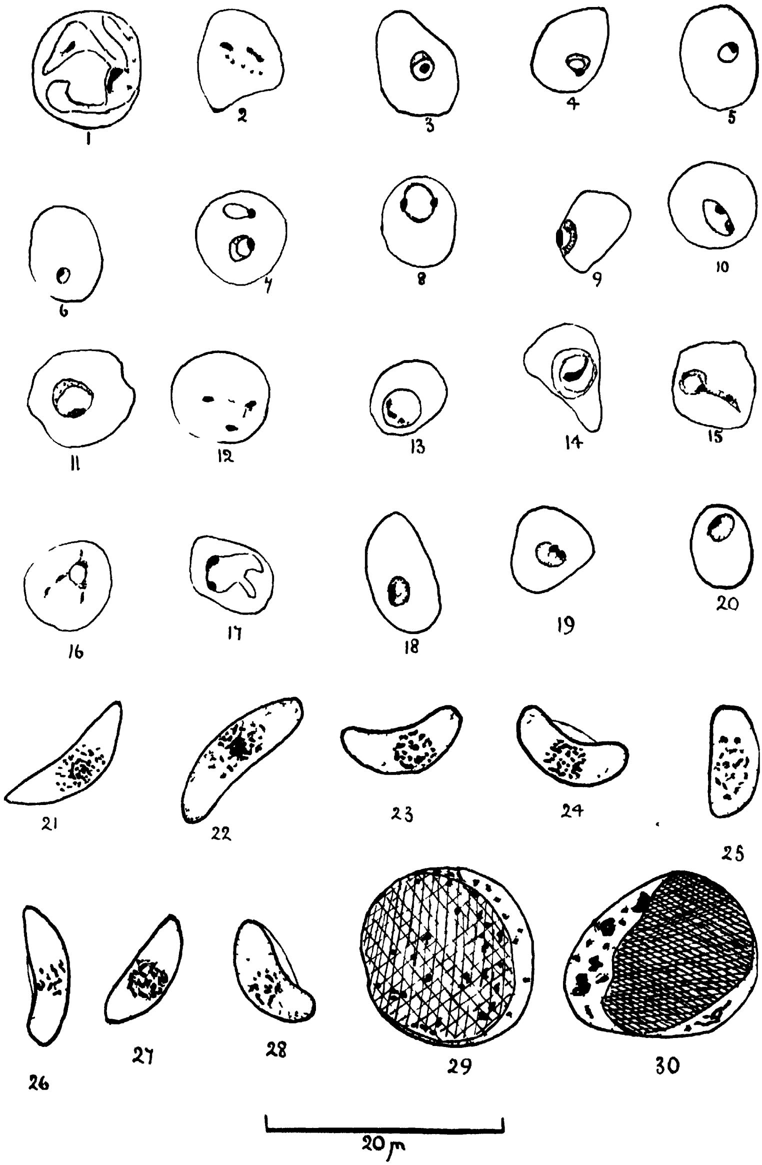
Forms of parasite found in the blood of the chimpanzee.

Fig. 1. *P. vivax*-like form.

Fig. 2. *P. malariae*-like form.

P. falciparum-like forms:—
- Figs. 3-10. Small rings.
- Figs. 11-14. Large rings.
- Figs. 15-17. Amoeboid forms.
- Figs. 18-20. Solid forms.
- Figs. 21-28. Crescent forms.

Pigmented leucocytes:—
- Fig. 29. Pale nucleus and finer pigment.
- Fig. 30. Dark nucleus and coarse pigment masses.



C. Tinling & Co Ltd., Imp

THE SIGNS OF FILARIAL DISEASE

BY

B. BLACKLOCK

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The signs of filarial disease are those signs which are held to have been produced by the previous pathological action of adult *Filaria bancrofti* and its embryos; so varied in their character are these signs and so diverse is their relationship to the presence of microfilaria in the cutaneous blood, that it is well to have some definite mode of tabulating them for purposes of comparison.

Stephens (1921) has established a standard which will prove of value in this direction, in his analysis of Manson-Bahr's (1912) Monograph on Filariasis. His tables I,* II, XII and XIII deal with the percentage occurrence of microfilaria in the blood in persons in whom the presence of signs has been established; his tables III, IV, XIV and XV deal with the percentage occurrence of signs in persons in whose blood the presence of microfilaria has been established; his table V deals with the percentage occurrence of microfilaria in the blood and the percentage occurrence of signs at different age periods, and his table VI deals with the same facts in respect to the localities in which the patients were examined.

The results obtained by me while examining natives at Mabang, in the Protectorate of Sierra Leone, are set out below in such a way as to be comparable with certain of those tables. The investigation was carried out during the months July and August, 1921; the number of persons (240) dealt with in this paper is the residue obtained after excluding cases which presented other microfilaria in the blood or were not sufficiently examined from refusal to have blood films taken. The hours during which the examinations were made were from 6 a.m. to 6 p.m.; there was a considerable gang of

* Professor Stephens has asked me to draw attention to the facts that in his Table I, 103 should read 108, and 19·5 should read 20·5; while in Table III, 269 should read 265, and 39·5 should read 38·7.

men who were employed, many of them in night-work on the river, cutting mangrove trees. This possibly contributed to the appearance of *Microfilaria bancrofti* in small numbers in the day time: the examination was confined to a stained thick film of each case. The notes of the occurrence of any pathological condition seen on examination were made first, and the blood films taken at the same time were examined afterwards. Before proceeding to the consideration of the tables, it is necessary to state that the figures in the tables are to a certain degree weighted on the side of 'signs of filarial disease.' For example, a diagnosis of elephantiasis was made to include not only cases such as are shown in the photograph (text-fig. 1), but also cases of oedema in which the hyperplasia

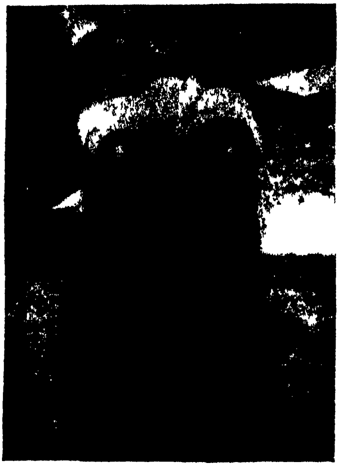

Fig. 1.

of the cutaneous structures was by no means an outstanding feature; also it includes very circumscribed conditions of hyperplasia with fissuring of the skin at the apex of the otherwise normal-looking scrotum. The influence of the length of the scrotum in producing such lesions is perhaps a factor deserving attention, in view of the frequency with which contact with the ground must occur in squatting down in the native fashion. In one case in which, however, there was no evidence of skin lesion, nor of any patho-

logical condition of the cord and testicles, the scrotum, on a foot-rule placed behind it against the perineal origin, measured ten inches. It is clear that a scrotum of much less dimensions than this will very frequently be in contact with the ground, and the risk of septic infection of the skin at the apex has to be considered. Again, a diagnosis of enlarged lymphatic glands was made to include two categories, one comprising fifty-eight cases in which the glands were visibly enlarged and another comprising seventy cases in which the glands were not visibly enlarged, but were considered on palpation to be enlarged. It is possible unconsciously to weight the 'signs' if the blood films are first examined and the micro-filaria-in-the-blood cases are examined subsequently for signs; the process is to a great degree governed by the pre-disposition of the individual in favour of what he may consider the signs properly to be associated with the existence, past or present, of filaria adults as shown by the presence of microfilaria in the blood. The risk of weighting the microfilaria is less owing to the fact that the observer usually has his own definite method of making his blood preparations; consequently, if he fails to find microfilaria in the usual sample taken from a case in which he has found signs, he could not take another larger sample in order to discover them without conscious effort. It would appear preferable, therefore, to make the notes of signs first and the examination of blood films afterwards.

TABLE I.

Showing percentage infected with microfilaria among those with and without signs of filarial disease* at Mabang.

	Number examined	Number infected with microfilaria	Percentage
With signs of filarial disease	138	29	21·0
Without signs of filarial disease	102	18	17·6

* The 'signs of filarial disease' selected for these tables are those included in Stephens' tables, i.e., enlarged glands, hydrocele, enlarged testis, abscess and elephantiasis.

CONCLUSION. Microfilaria is commoner among those with signs of filarial disease than among those without signs of filarial disease.

TABLE II.

Showing percentage infected with microfilaria among those with and without particular signs of filarial disease at Mabang.

	Number examined	Number infected with microfilaria	Percentage
With elephantiasis	11	2	18·2
Without elephantiasis	229	45	19·6
With enlarged glands	128	29	22·6
Without enlarged glands	112	18	16·1
With hydrocele	9*	1	11·1
Without hydrocele	176*	44	25·0
With enlarged testis	7*	1	14·3
Without enlarged testis	178*	44	24·7
With abscess	8	0	0
Without abscess	232	47	20·2

* Males.

CONCLUSION. Microfilaria is commoner among those with enlarged glands than among those without enlarged glands; microfilaria is less common among those with elephantiasis, hydrocele, enlarged testis and abscess than among those without these signs of filarial disease.

The effect of considering as signs of filarial disease only those glands which are visibly enlarged is as follows.

TABLE IIA.

Showing percentage infected with microfilaria among those with and without visibly enlarged glands at Mabang.

	Number examined	Number infected with microfilaria	Percentage
With visible glands	58	11	19·0
With no visible glands	182	36	19·7

CONCLUSION. Microfilaria is less common among those with enlarged glands than among those without this sign of filarial disease.

In addition to the above lesions, notes are available of conditions not usually considered to be associated with filarial disease, namely, hernia and ulcers.

TABLE IIB.

Showing percentage infected with microfilaria among those with and without hernia and ulcers at Mabang.

	Number examined	Number infected with microfilaria	Percentage
With hernia	15	3	20·0
Without hernia	225	44	19·5
With ulcers of skin	18	2	11·1
Without ulcers of skin	222	45	20·3

CONCLUSION. Microfilaria is commoner among those with hernia than in those without hernia, but is less common among those with ulcers than among those without ulcers.

TABLE III.

Showing percentage exhibiting signs of filarial disease among those with and without microfilaria at Mabang.

	Number examined	Number with signs of filarial disease	Percentage
With microfilaria	47	29	61·7
Without microfilaria	193	109	56·5

CONCLUSION. Signs of filarial disease are commoner among those infected with microfilaria than among those not infected with microfilaria.

TABLE IV.

Showing percentage exhibiting particular signs of filarial disease among those with and without microfilaria at Mabang.

	Number examined	Number with particular signs of filarial disease	Percentage
		ELEPHANTIASIS	
With microfilaria	47	2	4·3
Without microfilaria	193	9	4·7
		GLANDS	
With microfilaria	47	29	61·7
Without microfilaria	193	99	51·2
		HYDROCELE	
With microfilaria	45	1	2·2
Without microfilaria	195	8	4·1
		ENLARGED TESTIS	
With microfilaria	45	1	2·2
Without microfilaria	195	6	3·1
		ABSCESS	
With microfilaria	47	0	0
Without microfilaria	193	8	4·1

CONCLUSION. Cases of enlarged glands are commoner among those infected with microfilaria than among those not infected with microfilaria: cases of elephantiasis, hydrocele, enlarged testis and abscess are less common among cases infected with microfilaria than in those not infected with microfilaria.

TABLE IVA.

Showing percentage exhibiting visibly enlarged glands among those with and without microfilaria at Mabang.

	Number examined	Number with particular signs of filarial disease	Percentage
		VISIBLE GLANDS	
With microfilaria	47	11	23·4
Without microfilaria	193	47	24·3

CONCLUSION. Visibly enlarged glands are less common among those infected with microfilaria than among those not infected with microfilaria.

TABLE IVB.

Showing percentage exhibiting hernia and ulcers of the skin among those with and without microfilaria at Mabang.

	Number examined	Number with particular signs of filarial disease	Percentage
		HERNIA	
With microfilaria	47	3	6·4
Without microfilaria	193	12	6·2
		ULCERS OF SKIN	
With microfilaria	47	2	4·2
Without microfilaria	193	16	8·3

CONCLUSION. Hernia is commoner among those infected with microfilaria than among those not infected with microfilaria: ulcers are less common among those infected with microfilaria than among those not infected with microfilaria.

TABLE V.

Showing percentage infected with microfilaria and percentage showing signs of disease at various age periods in the population examined at Mabang.

Age period	Number examined	Percentage infected with microfilaria	Percentage showing sings of filarial disease	
		MALES		
1–10	7	0	42·8	42·8*
11–20	48	12·5	58·3	54·2*
21–30	93	36·5	75·3	67·7*
31–40	24	16·6	62·5	45·8*
41–50	11	0	63·6	45·4*
51–60	2	50·0	...	...
		FEMALES		
1–10	11	0	36·4	...
11–20	9	11·1	11·1	...
21–30	16	0	25·0	...
31–40	9	0	22·2	...
41–50	10	10·0	40·0	...
51–60	0	0	...	...

* Hydrocele and enlarged testis excluded.

CONCLUSION. The results, so far as they can be considered from such small numbers in some groups, do not agree closely with those in Stephens' Table V, which is produced here for comparison with the above and for other reasons.

TABLE VI.

Showing percentage infected with microfilaria and percentage showing signs of disease at various age periods in the population examined in Fiji.

Age period	Number examined	Percentage infected with microfilaria	Percentage showing signs of filarial disease	
		MALES		
1–10	85	1·2	18·8	18·8*
11–20	117	21·4	59·0	59·0*
21–30	108	39·8	64·8	64·8*
31–40	83	47·0	78·3	78·3*
41–50	63	52·4	69·8	66·6*
51–60	35	37·1	71·4	62·8*
61–	21	38·1	76·2	61·9*
		FEMALES		
1–10	66	10·6	9·1	...
11-20	108	24·0	20·3	...
21–30	124	22·6	31·4	...
31–40	61	22·9	34·4	...
41–50	41	34·1	26·8	...
51–60	19	26·3	52·6	...
61	13	30·7	23·0	...

* Hydrocele and enlarged testis excluded.

CONCLUSION. No close relationship between the two sets of percentages is evident.

There are in the above table several figures which appear to me to be of great interest. It will be observed that in the males of the age period 1 to 10 there are 1·2 per cent. infected with microfilaria; total examined eighty-five. In females, however, in the same age period, there are 10·6 per cent. infected with microfilaria; total examined sixty-six. Again the percentages of males infected in periods 1 to 10 and 31 to 40 are in the ratio 1 : 39·2, while the percentages of females infected with microfilaria in the same age

periods are in the ratio 1 : 2·2. These figures appear somewhat anomalous, but not more so than the following. At the age period 1 to 10 in males, while 1·2 per cent. are infected with microfilaria, 18·8 per cent. show signs of filarial disease; total examined eighty-five.

Let us suppose for a moment that pre-existing infection with *Filaria bancrofti* can be detected by two means:—

(1) Presence of microfilaria in the blood.

(2) Presence of signs of filarial disease.

If one refers to the figures above, one observes that in the 1 to 10 age period in males we find 15·7 times as many sign cases as microfilaria cases. That is, roughly, of sixteen boys of 1 to 10 years of age infected with this filaria, fifteen are diagnosable by signs, while only one is diagnosable by blood examination. This would be a very remarkable fact, and would have been worthy of attention being drawn to it, had it not been difficult to understand why girls of the same age period gave a totally different ratio, the sign cases in girls of 1 to 10 years being only 9·1 per cent., while the microfilaria cases are 10·6 per cent.; sixty-six examined.

One explanation which can be suggested is that in boys the signs of filarial disease come into evidence without or before the appearance of microfilaria in the blood, while in girls of the same age the signs of filarial disease are accompanied by the presence of microfilaria in the blood. How to explain the facts, if we accept this hypothesis, is the next question; the early prominence of signs of filarial disease in boys might be attributed to the fact that in the figures for boys there are included the signs which appear under the designation hydrocele and enlarged testis, which signs are not represented in the figures for girls. It is possible to suppose that filaria attack the male genitals early in life and that two results arise from this, the first positive, *i.e.*, the production of lesions, hydrocele and enlarged testis; the second negative, *i.e.*, the failure of the adult to produce microfilaria in the blood. A glance at the extension column shows us that this explanation does not suffice; there we see that even excluding the male genital signs, namely hydrocele and enlarged testis, the figure representing signs of filarial disease in males 1 to 10 remains the same. In fact, it appears that signs of filarial disease affecting the male genitals do not even exist in this age period.

The absence of any standard by which to judge what may properly be considered as 'signs of filarial disease' may be the reason for the anomalies referred to; it appears probable that 'signs of filarial disease' is a term which requires a further and critical examination and modification. Although enlargement of the spleen may reasonably be called a sign of malarial disease, it would often be erroneous to diagnose malaria simply from enlargement of the spleen. To diagnose filarial disease from the discovery of enlarged glands, hydrocele, and so on, may be no less misleading.

SUMMARY

1. Two hundred and forty cases were examined at Mabang, Protectorate of Sierra Leone, in July-August, 1921, with a view to establishing a correlation between 'signs of filarial disease' and the occurrence of *Microfilaria bancrofti* in the blood.

2. The figures obtained do not show the same kind of correlation in these respects as do Stephens' figures, obtained by analysing Manson-Bahr's Fiji cases.

3. The figures obtained show that in this series many of the 'signs of filarial disease' have no more correlation with the presence of microfilaria in the blood than has hernia; some have less.

TWO FURTHER CASES OF CARDIAC ANEURYSM

BY

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AND

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(*Received for publication* 3 *April*, 1922)

PLATE X

The two following cases of cardiac aneurysm recently examined at Accra in the Gold Coast, West Africa, the one of the left auricle and the other of the anterior cusp of the mitral valve, are briefly recorded on account of their comparative rarity, and because they form a somewhat interesting series with the cases previously described by us (1920).

CASE I. A European man, aged about thirty-two years, who died suddenly on the beach at Accra when waiting to be conveyed on board the homeward-bound mail steamer. During the latter part of the war, the deceased served in the Flying Corps and lost his right arm as the result of an accident, the arm having been injured by coming in contact with a moving propeller. Previous to this he had been employed by a firm of contractors in the Gold Coast, and at the end of the war he returned to this Colony as a foreman in the Public Works Department. At the time of his death he had just concluded a year's tour of service spent at Accra, or in the neighbourhood of that town.

We are indebted to Dr. C. V. LeFanu for the following clinical notes of the case. Five months before his death the patient had a slight attack of malaria, but with this exception had not reported 'sick' during his tour. A week before he should have sailed for England he was examined for his Final Medical Certificate. Upon auscultation of his heart a peculiar bruit was noted, which Dr. LeFanu described as being of a quality such as he

had not previously heard. This bruit was most distinct in the pulmonary area, in the neighbourhood of a small scar which was present in the second intercostal space close to the edge of the sternum. There was no history or evidence of syphilis. The patient had been medically examined upon several occasions during the last year or two, and had not been informed after any of these examinations that there was anything the matter with his heart. During the war he was passed as fit for the Flying Corps, and a year before his death the Medical Adviser to the Colonial Office had passed him as fit to take up the duties of a foreman in the Public Works Department, work which is well known to entail heavy manual labour. It is, therefore, unlikely that this heart condition was of old standing, but it may be mentioned that the patient himself stated that he had always thought that his heart was affected, although he could give no history of symptoms in support of this idea. He was informed by Dr. LeFanu that his physical condition did not justify his return to West Africa, and was cautioned with regard to the risk he would run in attempting any strenuous muscular effort. Nevertheless, a few days later, as has already been stated, he fell dead on the beach when waiting to embark on the homeward-bound steamer.

At the autopsy it was found that the right arm had been amputated slightly above the middle of the shaft of the humerus, and a small scar about the size of a shilling was observed on the skin in the second left intercostal space half an inch from the sternal margin. In view of the pathological condition subsequently found, it may be stated at once that this scar was superficial, and that a careful examination failed to reveal any deep-seated injuries connected with it. Upon opening the thorax the pericardial sac was seen to be greatly distended, measuring vertically about eight inches and horizontally six and a half inches, and displaced the lungs on either side. It contained fluid blood under considerable pressure, so that on first opening it a jet of blood was projected for a distance of about a yard. About one pint of blood issued from the pericardium, and several recent clots were removed when the sac was fully opened. With the exception of the condition of the heart to be described immediately, the organs of the body appeared to be healthy.

The *heart* was not enlarged, but showed a considerable deposit of epicardial fat. Upon inverting the perciardium a discoloured, purple patch was found situated over the left auricular appendix. This patch was about as large as a broad-bean, and some tags of fibrin were adhering to it. On opening the heart the left auricular appendix was found to be dilated, its endocardium discoloured in a similar manner to the patch on the outer surface already mentioned, and its wall thin, smooth (owing to the disappearance of the pectinate arrangement of the muscles) and very friable. On examining the auricular appendix, the finger penetrated the wall and appeared in the discoloured patch on the outer surface, so that it was clear that it was through a rupture in this situation that the blood had escaped into the pericardium. With the exception of a few tiny, pearl-like vegetations at the margins of the mitral cusps on their auricular surfaces, no other abnormalities were observed in the heart or the great vessels at its base. The muscle of the walls of the ventricles appeared to be healthy, but it is to be regretted that circumstances did not permit of a detailed microscopical examination being made.

The condition of the left auricle in this case, the thinning of the wall, its friability, and the loss of its muscular rugosity, indicate that the dilatation was actually an aneurysm, and that this had finally ruptured, causing the death of the patient. According to Hall (1903), aneurysms of the chambers of the heart other than the left ventricle are 'no more than pathological curiosities, and are of the very rarest occurrence.' With regard to the left auricle, he states that Younge and Dreschfeld have each published a case of aneurysm of this cavity, and that in Younge's case, a man aged twenty-eight years, the cardiac valves were healthy, and in Dreschfeld's, a woman aged fifty-eight years, there was great stenosis of the mitral orifice. The case we have described resembled the former case more closely than the latter, for with the exception of a few small vegetations on the mitral cusps the cardiac valves were healthy. Rupture of the left auricle, indeed, appears to be a very uncommon occurrence; Odriozola (quoted by Hektoen and Riesman) recording it only in two cases in a series of one hundred and thirty-two cases of rupture of the heart. Unfortunately we are unable to make any suggestions as to the cause of the condition in our case, but so far

as the evidence went there was no reason to suppose that syphilis had anything to do with it. The detection of a remarkable bruit by Dr. LeFanu a few days before the death of the patient is of interest, since such observations are seldom made.

CASE II. A European man, aged thirty-six years, who died at Accra in February, 1922, of heart failure after an illness which had lasted about a month. His blood serum, tested on the eighth day of his illness, agglutinated *B. typhosus* in dilutions up to 1 : 125, and was negative to *B. para-typhosus* A and B; it also gave a weak positive Wassermann test and a positive Sachs-Georgi test. We are indebted to Dr. C. V. LeFanu for the following clinical account of the case.

In 1914 the patient was accepted for active service in a line regiment, served both in Gallipoli and France, and remained with the colours for five years. In 1916 he had some eye trouble, the nature of which is not known. In December, 1920, he joined the Gold Coast Service, and arrived in the Colony in the following January, so that at the time of the commencement of his last illness he had just completed a tour of twelve months and was expecting orders to return to England on leave. During his tour of service his name had appeared on the sick-list only once, namely, from the 16th of May to the 5th of June, on account of an attack of subtertian malaria. It is of interest to note that on this occasion no cardiac bruit was noted. The patient claimed to have lived a perfectly normal existence, and no history of syphilis or rheumatism was elicited.

On the 10th of January, 1922, the patient complained of fever and malaise. Two days later he was admitted to hospital. His symptoms were as follows:—Temperature 101° F. Tongue clean. Pupils strongly contracted ('pin-point') and reacting only very slightly to light. Very marked clubbing of all the finger-tips. Pulse 116, of Corrigan type; strong pulsations visible in the neck. The chest literally rocked with the cardiac action; the apex impulse was in the sixth interspace three-quarters of an inch inside the left nipple line. A rough double bruit was audible over the aortic and mitral valves, and a loud double bruit was also audible posteriorly to the left of the vertebrae, extending approximately from the seventh or eighth spinous process downwards. The radial arteries

were atheromatous. The liver was slightly enlarged downwards. The spleen extended well below the costal margin. The urine contained a trace of albumen. The action of the bowels was normal. No malaria parasites were found in the blood.

On the 18th of January a few scattered petechial spots were observed on the shoulders, chest and abdomen. Ten days later a slight, dry cough developed, followed two days later by signs of consolidation in both lungs, and subsequently by signs of pleural effusion on the right side. On the 10th of February the patient died suddenly in his sleep. The irregular fever and the oscillations of the pulse rate during the illness are shown in the chart. It may be remarked that it is somewhat strange that the gross cardiac lesions, which must have existed for years, had not previously been detected, although the patient must have been medically examined repeatedly in the Army and before coming to West Africa. With reference to the eye condition, the severity of the illness unfortunately prevented a more careful enquiry being made into the cause of the pupillary contraction which had been known to exist since 1916, and which continued unchanged throughout the illness.

At the autopsy both lungs showed broncho-pneumonic consolidation, especially of the upper lobes. The right pleural cavity contained about 30 ounces of a clear straw-coloured effusion. The liver was depressed, and was also considerably enlarged and in a state of chronic venous congestion. The spleen was enlarged and congested. In addition to the condition of the heart, presently to be described, the pericardium contained a small excess of fluid, but there were no adhesions.

The *heart* (Plate X, and text-fig.) was hypertrophied, weight about 17 ounces. The right side was slightly dilated, but otherwise presented no gross abnormalities. The wall of the left ventricle was hypertrophied, but appeared to be healthy. The aortic valves bore firm vegetations, apparently of some considerable age; the first part of the aorta was the seat of extensive atheromatous disease, and the orifices of the coronary arteries were patulous. The principal lesion was found, however, in the anterior cusp of the mitral valve. From the middle of this cusp, projecting towards the auricle, was a large aneurysmal sac which had ruptured, leaving a wide, irregular opening. The diameter of this aneurysmal sac was about 12 mm.,

and it was produced on the side directed towards the apex of the cusp into a rounded process measuring about 10 mm. in length and 9 mm. in thickness. Round the ragged margin of the ruptured portion of the aneurysm were a few small vegetations, and in the marginal portions of the cusp not involved in the aneurysmal dilatations were numerous small, white, thickened areas. Sections of the wall of the left ventricle appeared to be almost normal; there

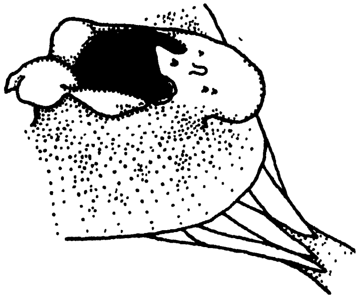
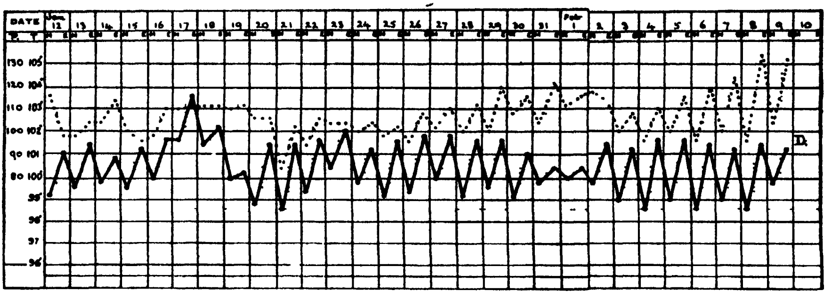


FIG. Case II. Sketch showing the ruptured aneurysmal sac in sub-lateral view.

was, however, a slight increase of the interstitial fibrous tissue. The coronary arteries showed a high degree of endarteritis. In the accompanying photograph (Plate X), the appearance of the aneurysm and the atheromatous condition of the aorta are fairly clearly seen, and in the figure, which is a rough sketch of the anterior cusp of the mitral valve as seen in a sub-lateral view, some of the characters of the lesion are more clearly indicated.

The site of the aneurysm in this case, the anterior cusp of the mitral valve, is that which, according to Drasch, is the more usual. The history of the case, the very pronounced clubbing of the finger-tips, etc., suggests that the cardiac lesion was of old standing, but caused the patient himself no inconvenience or discomfort, and gave rise to signs so slight that they escaped detection at medical examinations such as that required in the case of officers proceeding to West Africa. The aneurysm of the mitral cusp, although of considerable size, was, in fact, in such a situation that it would not necessarily interfere with the efficient closing of the valve. The rupture of the aneurysm at its apex was, it may be supposed, the immediate cause of the sudden development of cardiac symptoms,

and the supervention of pneumonic infection the determinate cause of death. The irregular fever, shown in the chart, before the onset of the pulmonary complications is suggestive of endocarditis, but we did not succeed after death in cultivating any pathogenic organism



CASE II. Chart of temperature (continuous line) and pulse (dotted line).

from the margin of the aneurysm. The results of the Wassermann and Sachs-Georgi tests, and the diseased state of the aorta, point to the probability that in this case the aneurysm had developed as the result of atheromatous processes.

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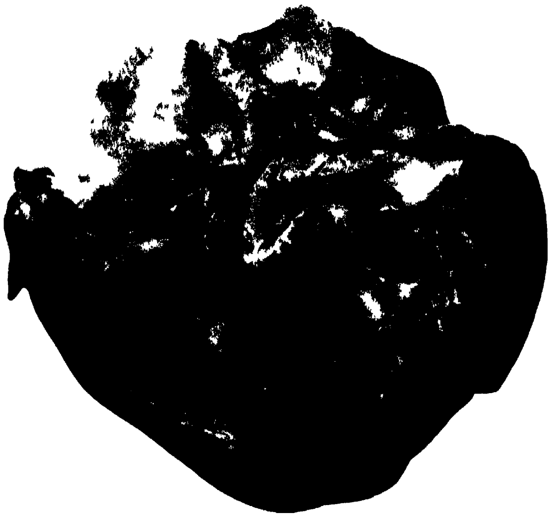
EXPLANATION OF PLATE X

Aneurysm of the anterior cusp of the mitral valve of the heart.



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CESTODES IN THE COLLECTION OF THE INDIAN MUSEUM

BY

T. SOUTHWELL

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A. MAMMALS

The parasites described below were obtained, with a few exceptions, from animals which died in the Zoological Gardens, Calcutta.

I do not propose dealing in this paper with the synonymy of the forms recorded.

Family *TAENIIDAE*, Ludwig, 1886

Taenia crassicollis, Rudolphi, 1810

1. One specimen from a cat. Punjab Civil Veterinary College, Lahore, 30.1.14.
2. Three complete specimens from the intestine of *Felis viverrina*. Zoological Gardens, Calcutta, collected by the author, 11.11.14.
3. Another specimen without a head, collected from the same host by the author, 17.2.16.
4. One specimen from the same host. Tollygunge, Calcutta, 9.4.20.

Taenia serrata, Goeze, 1782

1. One specimen from *Felis tigris*. Sukna, Darjeeling district, Bengal, 17.3.17.
2. Two complete and mature specimens from same host, shot at Sevoke, Darjeeling district, Bengal, 3.2.17.

Taenia pisiformis (Bloch, 1780), Gmelin, 1790

One complete specimen from intestine of *Felis leo*. Zoological Gardens, Calcutta, collected by the author, 3.1.16.

Taenia sp.

Eight specimens from the intestine of *Felis pardus*. Zoological Gardens, Calcutta, collected by the author, 19.1.15.

The specimens measured about 1 cm. long and 0·5 mm. broad; they were all immature, no trace of genitalia being visible.

The head was armed with a double row of hooks, the number varying from thirteen to seventeen in each row. The large hooks measured from 135μ to 145μ, and the smaller from 90μ to 100μ.

About fifty segments only were present; the neck measured about 750μ. As the specimens were quite immature, it was impossible to say whether they were new or not.

The following species have been recorded from:—

(1) *Felis concolar*

(*a*) *T. ammonitiformis*, Baird, 1862, possesses only a single row of hooks.

(*b*) *T. oligarthra*, Diesing, 1863, has only three to four segments.

(2) *Felis pardus*

(*a*) *T. polycalcaria*, Linstow, 1903, possesses two rows, each row with nineteen hooks, measuring 238μ and 158μ.

(*b*) *T. serrata*, Goeze, 1782, has two rows each with twenty to twenty-one hooks, which measure 250μ to 260μ and 150μ to 155μ.

It is, of course, quite probable that in the worm in question the hooks would have increased in size as it matured, and that it may be either of the last two species.

Taenia sp.

Fragments comprising a few segments (all sterile) of what appeared to be a *Taenia* sp. were obtained from the intestine of a dog at Lahore. No date.

Taenia sp.

Fragments from the intestine of *Felis tigris*. Zoological Gardens, Calcutta, collected by the author, 22.2.16.

No head was present and no gravid uterus, hence the determination of these fragments was impossible, but superficially they resembled segments of *T. serrata*.

Taenia sp.

One specimen without head from the intestine of *Ursus torquatus* (bear). Zoological Gardens, Calcutta, collected by the author, 21.9.15.

The worm measured about 1 m.; the segments at the anterior end were square and mature. The genital pore was prominent, and, in gravid segments, was situated posterior to the middle of the segment. The worm resembles *T. pisiformis* externally, but the eggs are round and measure 40μ to 45μ; those of *T. pisiformis* are oval and measure about 37μ by 32μ.

Cysticercus fasciolaris, Rudolphi, 1808

1. *Mus rattus*. Berhampore, Bengal. Collected by Lt.-Col. Clayton Lane and numbered Z.E.V. $\frac{5416}{7}$ in the collection of the Indian Museum. No date.

2. *Mus decumanus*. Collected by Lt.-Col. Alcock and numbered Z.E.V. $\frac{2367}{7}$ in the collection of the Indian Museum. Locality and date not given.

3. Rat. Civil Veterinary College, Lahore. Numbered Z.E.V. $\frac{4672}{7}$ in the collection of the Indian Museum. No date or locality given.

4. Liver of rat. Collected by Dr. D. E. Muir. No date or locality given.

5. *Mus rattus*. Calcutta. Collected by Lt.-Col. Clayton Lane. Numbered Z.E.V $\frac{927}{7}$ in the collection of the Indian Museum. No date.

Cysticercus cellulosae (Gmelin, 1790), Rudolphi, 1808

One specimen from human brain, Colombo, collected by the author, June, 1911.

Cysticercus tenuicollis, Rudolphi, 1810

Four specimens from the four-horned antelope (*Tetracercus quadricornis*). Zoological Gardens, Calcutta, collected by the author, February, 1914.

Cysticercus sp.

Collected by Capt. Boulenger, 14.12.18. Host and locality unknown.

Family *HYMENOLEPIDIDAE*, Railliet and Henry, 1909

Sub-family (1) *HYMENOLEPIDINAE*, Ransom, 1909

Hymenolepis murina (Duj., 1845), R. Blanchard, 1891

A few specimens from the following sources:—

1. No history. Numbered Z.E.V. $\frac{4689}{7}$ in the collection of the Indian Museum.

2. From a rat. Civil Veterinary College, Lahore, Punjab, no date. Numbered Z E.V. $\frac{4672}{7}$ in the collection of the Indian Museum.

3. From *Mus decumanus*, collected by Lt.-Col. Alcock, I.M.S., Calcutta. No date. Numbered Z.E.V. $\frac{2367}{7}$ in the collection of the Indian Museum.

Hymenolepis diminuta (Rudolphi, 1819), R. Blanchard, 1891

1. A few specimens from the intestine of a rat, London. Numbered W. $\frac{16}{1}$ in the collection of the Indian Museum.

2. A few specimens from the intestine of *Mus rattus*, Hong Kong, collected by Capt. F. H. Stewart, I.M.S., and numbered W. $\frac{17}{1}$ in the collection of the Indian Museum. No date.

Sub-family (2) *DIPYLIDIINAE*, Stiles, 1896

Dipylidium caninum (Linn., 1758), Railliet, 1892

1. From a cat, Egypt. Numbered Z.E.V. $\frac{2979}{7}$ in the collection of the Indian Museum. No date.

2. From the intestine of a cat, Punjab Civil Veterinary College, Lahore, 30.1.14.

3. From the intestine of a dog. Numbered Z.E.V. $\frac{5505}{7}$ in the collection of the Indian Museum. Locality and date not given.

4. From the intestine of a dog, Lahore. No date. Numbered Z.E.V. $\frac{4675}{7}$ in the collection of the Indian Museum.

5. From the intestine of a dog, Ceylon Medical College, Colombo. Numbered Z.E.V. $\frac{5507}{7}$ in the collection of the Indian Museum. No date.

6. Several specimens. Locality, host, and date not given. Numbered Z.E.V. $\frac{2979}{7}$ in the collection of the Indian Museum.

7. Two specimens from the intestine of *Felis viverrina*. Zoological Gardens, Calcutta, 23.5.19.

8. Three specimens from the intestine of *Hyaena striata*. Zoological Gardens, Calcutta, collected by the author, 17.8.15.

9. Several specimens from *Paradoxurus grayi* (Himalayan palm-civet). Zoological Gardens, Calcutta, collected by the author, 29.3.15.

Dipylidium gervaisi, Setti, 1895

1. One specimen from the intestine of *Felis viverrina*. Zoological Gardens, Calcutta, 30.5.19.

2. Several specimens from the intestine of *Paradoxurus hermaphroditicus* (Malayan palm-civet). Zoological Gardens, Calcutta, collected by the author, 18.5.15.

Family *ANOPLOCEPHALIDAE*, Führmann, 1907

Sub-family *ANOPLOCEPHALINAE*, Blanchard, 1891

Anoplocephala vulgaris, Southwell, 1920

One specimen from *Rhinoceros sondiacus*. No date or locality. Numbered Z.E.V. $\frac{4680}{7}$ in the collection of the Indian Museum.

From a superficial examination of this worm in 1916, I was led to the opinion that it probably belonged to the genus *Thysanosoma*. A more careful examination of the anatomy has, however, left no doubt that it is an *Anoplocephala*, identical with the species *vulgaris*.

Bertiella satyra (R. Blanchard, 1891), Stiles and Hassall, 1902

One specimen without head, from the intestine of *Simia satyrus*. Zoological Gardens, Calcutta, collected by the author, 5.4.16.

Cittotaenia mosaica, Hall, 1908

A few specimens from *Lepus ruficaudatus*, Songara, Gonda district, United Provinces, India. Museum collector (R. Hodgart). Numbered Z.E.V. $\frac{2771}{7}$ in the collection of the Indian Museum. As a result of a preliminary examination, this species was identified as *C. bursaria*, Linstow, 1906. More careful examination of prepared

slides left no room for doubt that they are identical with Hall's specimens.

Moniezia trigonophora, Stiles and Hassall, 1892

1. An immature specimen from the intestine of a black buck (*A. cervicapra*). Zoological Gardens, Calcutta, collected by the author, 30.8.13. Numbered Z.E.V. $\frac{6044}{7}$ in the collection of the Indian Museum.

2. One specimen from the intestine of a four-horned antelope (*Tetracercus quadricornis*. Zoological Gardens, Calcutta, collected by the author, 19.8.19.

Moniezia oblongiceps, Stiles and Hassall, 1893

One specimen from the intestine of a domestic goat, Rangoon, Burma, collected by Dr. A. A. Marshall, 8.8.16.

Moniezia alba (Per., 1879), R. Blanchard, 1891

1. A few specimens from the intestine of *Bos grunniens* (Yak), Tibet, 26.6.16.

2. Other specimens of this species were obtained from sheep, Civil Veterinary College, Lahore, Punjab, 31.1.14.

Moniezia expansa (Rudolphi, 1810), R. Blanchard, 1891

One specimen from the intestine of a domestic goat, Rangoon, *cercus quadricornis*). Zoological Gardens, Calcutta, collected by the author 1.2.13, and numbered Z.E.V. $\frac{6160}{7}$ in the collection of the Indian Museum.

Moniezia neumanni, Moniez, 1891

One specimen from the intestine of a sheep. Civil Veterinary College, Lahore, Punjab, 31.1.14.

Avitellina centripunctata (Riv., 1874), Gough, 1911

Numerous specimens from cattle. Civil Veterinary College, Lahore, Punjab. No date.

Stilesia globipunctata (Riv., 1874), Railliet, 1893

Numerous specimens from sheep. Civil Veterinary College, Lahore, Punjab, 31.1.14.

Family *DIBOTHRIOCEPHALIDAE*, Lühe, 1902

Bothriocephalus maculatus (Leuckart, 1848), Lühe, 1899

Very numerous specimens, all immature, measuring about 10 cms. long and 1·5 mm. broad, from the intestine of *Felis pardus* (black leopard). Zoological Gardens, Calcutta, collected by the author, 31.12.14.

Bothriocephalus sulcatus (Molin, 1858), Linstow, 1878

Two small specimens measuring about 10 cms. long and 3 mm. broad, from the intestine of *Felis pardus*. Zoological Gardens, Calcutta, collected by the author, 5.2.14.

Bothriocephalus decipiens (Diesing, 1850), Lühe, 1899

1. Very numerous specimens (mostly just mature), from the intestine of *Felis tigris*. Zoological Gardens, Calcutta, 23.2.19.

2. Another specimen without head, which appeared to belong to this species, was obtained from the intestine of *Felis pardus*. Zoological Gardens, Calcutta, collected by the author, 10.2.16.

Bothriocephalus sp.

One specimen from a black leopard. Collected by the author, 12.5.13.

The specimen measured 2 cms. long and its greatest breadth was 1·2 mm. As it was quite immature, it is impossible to assign it to any particular species.

Bothriocephalus sp.

From *Paradoxurus grayi* (Himalayan palm-civet). One specimen 10 cms. long and 6 to 7 mm. wide. No head. Zoological Gardens, collected by the author, 19.2.16.

Order *TETRAPHYLLIDEA*, Carus, 1863

Genus *Ophiotaenia*, La Rue, 1911

The systematic position of this genus within the above order is a matter of some uncertainty.

Ophiotaenia punica (Cholodkovski, 1908), La Rue, 1911

Four specimens (one immature), from *Paradoxurus hermaphroditicus* (Malayan palm-civet). Zoological Gardens, Calcutta, collected by the author, 18.5.15.

The largest specimen measured about 30 cms. long and 4 mm. broad. The cirrus was spiny; otherwise the worm agreed in detail with the description of this species given by La Rue.

Cholodkovski obtained the parasite from a dog in Tunis (1908); Hall, Ransom and La Rue were all of opinion that the normal host is a snake, and that the presence of the worm in a dog was to be accounted for by the dog having eaten a snake. On this hypothesis we have to assume that the Malayan palm-civet must likewise have eaten a snake which harboured the adult worm, but its presence in both a dog and a cat, each from different localities, is of note.

Cestoda sp.

About ten segments of a worm from the intestine of *Loris gracilis*. Zoological Gardens, Calcutta, collected by the author, 29.7.16. They measure about 2 mm. wide and are much broader than long. The genital pores are irregularly alternate. The ovary is central, anterior and fan-shaped, the testes being posterior and extending across the segment. The cirrus is unarmed. Eggs round and measuring 35μ, not in capsules; they have double coverings and contain a hexacanth embryo. Pyriform apparatus absent. Owing to lack of material and the absence of a head, it is impossible to say with certainty to which genus the specimens belong.

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B. PIGEONS

Moniezia columbae, Führmann, 1902
= *Paronia carrinoi*, Diamare, *ex parte*

One specimen, without head, consisting of ripe, but not gravid, segments, from a pigeon (sp. ?), Berhampur, Bengal, India, 29.4.11.

Davainea spiralis, Baczynska, 1914

1. One specimen from a common pigeon (*Columba* sp.). Zoological Gardens, Calcutta, India, 25.4.19.

The uterus was not developed, but the prostatic glands were well defined. The specimen was mounted.

2. Two complete specimens, two large worms without heads and ten fragments were obtained from the intestine of *Crocopus phoenicopterus* Zoological Gardens, Calcutta, India, collected by the author, 28.1.16.

Our specimens agreed with Baczynska's description, except in the matter of length. Whilst the types measured only 3 to 4 cms. long, our specimens measured 15 cms. long, the posterior 12 cms. being composed of gravid segments only.

3. About eight specimens of this species from intestine of a common pigeon, *Columba* sp. Zoological Gardens, Calcutta, 11.12.20.

In these specimens the number of testes varied between twelve and twenty, the greater number being invariably situated on one side.

Davainea anatina, Führmann, 1908

1. Four specimens from a pigeon (*Columba* sp.). Chilka Lake, Orissa, collected by the author. No date.

This species has hitherto only been recorded from *Anas boschas* dom.

2. An immature worm with a head and a few fragments, probably of this species, obtained from *Crocopus phoenicopterus* (green pigeon). Chilka Lake, Orissa, India (Chilka Survey), 22.11.14.

Davainea ceylonica, Bacz, 1914

1. Several fragments, without head, from *Crocopus phoenicopterus*. Zoological Gardens, Calcutta, India, collected by the author, 8.1.14.

2. Several worms, without heads, from *Columba leuconata*, Vig. (white-bellied pigeon). Zoological Gardens, Calcutta, India, collected by the author, 1.5.15.

3. One specimen from *Crocopus phoenicopterus*. Chilka Lake, Orissa, India (Chilka Survey), 22.11.14.

DAVAINEA FÜHRMANNI, n. sp.

1. Several complete specimens from *Crocopus phoenicopterus* (green pigeon). Zoological Gardens, Calcutta, Bengal, India, collected by the author, 26.1.14.

2. Numerous complete specimens from same host. Zoological Gardens, Calcutta, collected by the author, 22.7.15.

3. About nine specimens from same host. Zoological Gardens, Calcutta, India, collected by the author, 10.1.17.

4. About ten specimens of this worm were obtained from same host. Zoological Gardens, Calcutta. No date.

5. About twelve specimens and a large number of fragments from *Crocopus phayrai* (green pigeon). Zoological Gardens, Calcutta, India, collected by the author, 1.1.18.

External Anatomy

The largest specimen was about 80 mm. long and 0·7 mm. broad. The worms exhibited very considerable variations; in young segments the pore was situated at the extreme anterior margin, whilst in mature and gravid segments it was slightly in front of the middle.

The segments varied in shape; in some worms they were all broader than long, except the last few, which were square; in other specimens the segments were somewhat bell-shaped, whilst in still other worms the terminal segments were twice as long as broad.

The longest posterior segment measured 1·2 mm. long and 0·7 mm. broad. The genital pores are unilateral.

Head. The average size of the head was about 250μ broad and 330μ long. The large rostellum, which was about 100μ long and 150μ broad, is armed with a double row of about one hundred and ten hammer-shaped hooks (fig. 2), measuring from 25μ to 30μ, the

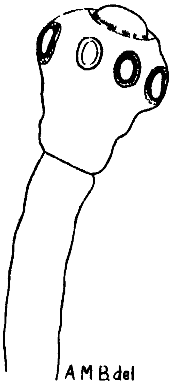

FIG. 1. *Davainea fuhrmanni*, n.sp. Showing head and neck. × 70.

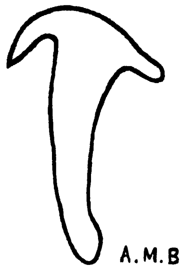

FIG. 2. *Davainea fuhrmanni*, n.sp. Hook from the rostellum. × 1,125.

hooks in the anterior row being slightly larger than those in the posterior row. The suckers have a diameter of about 70μ and are armed with several rows of minute hooks (fig. 1). In six of our specimens no trace of hooks was to be found on the suckers; they had apparently fallen off.

Neck. The neck varied in length from 0·3 mm. to 1·4 mm.

Nervous system. There is a single nerve situated lateral to the ventral water vessel and ventral to the cirrus pouch.

Muscular system. The longitudinal muscles are well-developed; the bundles are arranged in a single layer, the external being smaller in every way than the internal bundles; the arrangement is best seen in young adults. The circular fibres consist of a very narrow layer lying immediately internal to the longitudinal fibres. Oblique fibres were very scanty.

Water vascular system. A single ventral vessel runs along each lateral margin; that on the pore side lies ventral to the cirrus pouch and is situated further from the lateral margin than is the aporal vessel. This asymmetry is not, however, always pronounced.

INTERNAL ANATOMY

Male genitalia. Testes. The testes lie dorsal, and are about twelve in number; seven or eight lie on the aporal side of the ovary, one or two lie posterior and lateral to the yolk gland, and the rest—usually three—lie on the pore side of the ovary. They do not extend beyond the water vessels (figs. 3 and 4).

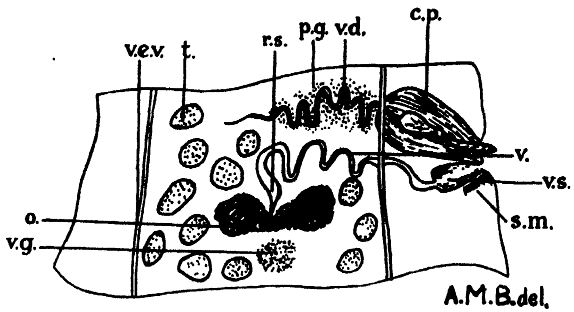

FIG. 3. *Davainea fuhrmanni*, n.sp. Segment showing male and female genitalia. *c.p.*—cirrus pouch; *o.*—ovary; *p.g.*—prostatic gland; *r.s.*—receptaculum seminis; *s.m.*—sphincter muscle; *t*—testes; *v.*—vagina; *v.d.*—vas deferens; *v.s.*—vaginal sinus; *v.e.v.*—ventral excretory vessel; *v.g.*—vitelline gland. × 140.

Vas deferens. The vas deferens is a long, loosely coiled, slightly dilated tube, extending quite half way across the segment and surrounded throughout its length by a dense mass of glandular tissue—the prostate gland; it reaches its full development somewhat late. As no seminal vesicle was observed, it would appear that the elongated vas deferens functions as a seminal vesicle. The cirrus pouch is large, measuring in mature segments about 170μ long and 80μ broad: it lies across the antero-lateral angle of the segment and extends just internal to the lateral water vessel. The cirrus is armed with large spinules, measuring about 17μ; these, however, cannot always be seen (figs. 3 and 4).

Female genitalia. Ovary. The ovary is bi-lobed, each lobe having a rounded appearance. It lies slightly behind the centre of the segment (figs. 3 and 4).

Receptaculum and vagina. The vagina is a long, muscular, sinuous tube; the terminal portion lying posterior to the whole length of the cirrus pouch is often, but not always, dilated. Its extreme lateral extremity lies at the base of a well pronounced sinus, situated immediately posterior to the cirrus pouch; a well developed sphincter muscle surrounds the opening of the vaginal sinus. Slightly anterior to the ovary the vagina dilates into a small but somewhat elongated receptaculum (figs. 3 and 4).

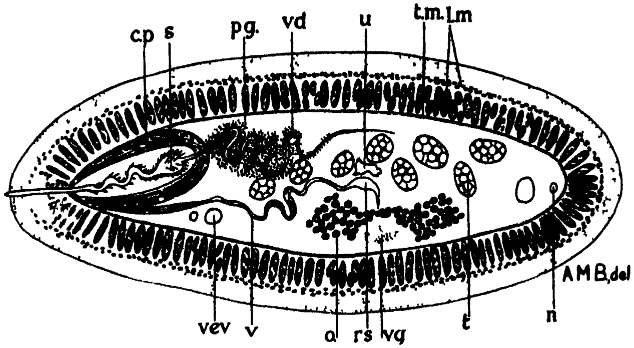

FIG. 4. *Davainea fuhrmanni*, n.sp. Transverse section showing male and female genitalia, etc. *c p*—cirrus pouch; *l m.*—longitudinal muscle; *n.*—nerve; *o.*—ovary; *p g.*—prostatic gland; *r.s.*—receptaculum seminis; *s.*—spines on cirrus; *t.*—testes; *t m.*—transverse muscle; *u*—uterus; *v.*—vagina; *v.d.*—vas deferens, *v.e.v*—ventral excretory vessel, *v g*—vitelline gland. × about 160.

Vitelline glands. This lies posterior to the ovary, and is easily seen. In size it is almost equal to one wing of the ovary (figs. 3 and 4).

Uterus. The uterus is first visible as a small, irregular cavity, situated immediately anterior to the vitelline gland. It enlarges rapidly, eventually filling the entire segment between the water vessels. The eggs, when first seen, appear as a dense granular mass filling the uterus. A few segments further back about forty capsules are differentiated, each containing six or seven, and rarely nine to eleven, oncospheres. At first the mature uterus lies strictly within the water vessels, but in the last five or six segments, the water vessels disappear and the entire segment is occupied by the capsules

(figs. 5 and 6). Black pigment occurs abundantly in the posterior two-thirds of the worm.

Eggs. These measure about 36μ.

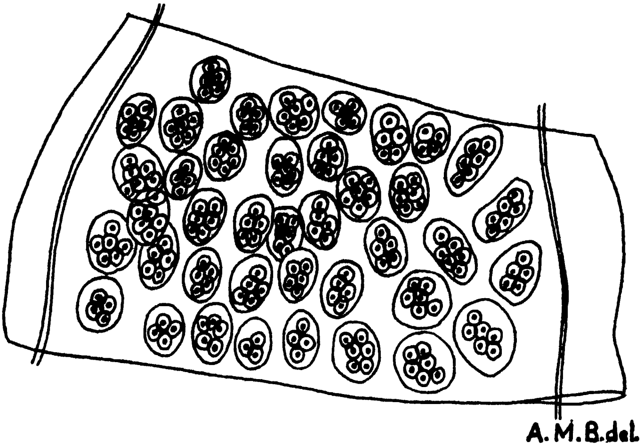

FIG. 5. *Davainea führmanni*, n.sp. Gravid segment showing eggs in capsules. × 120.

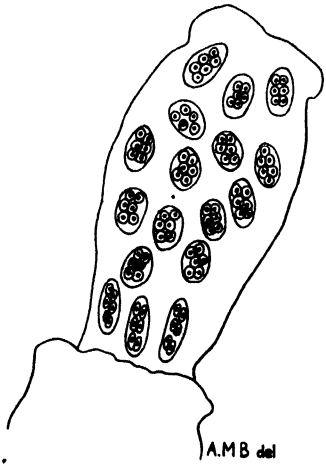

FIG. 6. *Davainea führmanni*, n.sp. Gravid segment showing eggs in capsules. × 60.

DIAGNOSIS

The species noted below have been recorded from *Columbiform* birds, and the table shows the principal points in which they differ from *D. führmanni.*

	Length	Breadth	No. of hooks	Size of hooks	Pores	No. of testes	No. of eggs per capsule
	mm.	mm.					
D. goura	170	1·1	300	9μ	unilat.	18-20	8-10
D. *cryptacantha*	120	1·5	170	7μ	"	8-12	several
D. spiralis	30-40	1·3	300	15·6μ	"	4-5	4-6
D. paucitesticulata ...	100	0·6	120	9-10μ	"	6-7	7-8
D. insignis	300	?	?	?	"	?	?
D. micracantha	100	0·8	160-200	13-14μ	"	12-16	4-5
D. columbae	70	1·0	120	11μ	irreg.	30	1
D. crassula, Fuhr. ...	250-400	4·0	70	20μ	"	30-40	3-4
" Clerc. ...	?	?	400	10μ	?	?	?
" Stiles ...	?	?	70	10μ	?	?	?
D. fuhrmanni, n.sp. ...	80	0·7	110	25-30μ	unilat.	About 12	6-7

I have been unable to obtain a description of *D. insignis* (Steud), but, according to Meggitt, it has armed suckers. The only species of *Davainea* possessing hooks about 28μ long are *D. mutabilis*, *D. campanulata*, *D. undulata* and *D. vaganda*. In the first two the pores are alternate and the suckers unarmed: *D. vaganda*, Baylis, has only six to eight testes. Führmann informs me that his species *D. undulata* is different from *D. fuhrmanni*, n. sp.

Our worm bears a general resemblance to *D. allomyodes*, Kotlán, 1921, especially in the following particulars:—

1. Size.
2. Unilateral pores.
3. The cirrus pouch and armed cirrus.
4. The vaginal sinus and sphincter.
5. Number of testes.
6. Number of eggs in each capsule.

It differs from *D. allomyodes* in the folowing respects:—

1. Size and number of hooks (one hundred and sixty to two hundred in *D. allomyodes*, measuring 17μ to 18μ).
2. No mention is made in the description of *D. allomyodes* of the very long, loosely coiled vas deferens.
3. Number of capsules per segment, viz., sixteen in *D. allomyodes* and at least forty in *D. führmanni*, n. sp.

Some variations in the number of capsules in each segment is to be expected, but in this case the difference is considerable.

Our species is, however, much more closely related to *D. ceylonica*, Bacz., 1914, obtained from *Pavo cristatus* in Ceylon, the very long vas deferens being thrown into loops in both species. They appear to differ, however, in the following characters:—

	Length	Breadth	Size of hooks	Spines on cirrus	Ovary	Vaginal sinus
	mm.	mm.				
D. führmanni	80	0·6-0·7	25-30μ	Present	Bi-lobed	Present
D. ceylonica	30-40	1·3	10μ	Not described	Fan-shaped	Not described

It will be clear that the principal difference lies in the size of the hooks, which, being hard, do not alter in size as the soft structures are liable to do.

The notable characters of *D. führmanni*, n. sp., are as follows:—

1. Large hooks on the rostellum 25μ to 30μ.
2. Suckers armed.
3. Long neck.
4. Pores unilateral.
5. Few testes (about twelve).
6. The large cirrus pouch.
7. Large spines on cirrus (measuring 17μ).
8. The very long, loosely coiled, vas deferens.
9. The large prostate gland.
10. The vaginal sinus with sphincter muscle.
11. Six or seven eggs per capsule.

I have great pleasure in naming this species in honour of Professor O. Führmann, of the Zoological Department, University of Neuchâtel, who has contributed so much to the science of Helminthology.

Davainea sp.

A fragment, without head, from a pigeon (*Columba* sp). Berhampur, Bengal, India, 1912.

Davainea sp. (? *paradisea*, Führ., 1908)

A head and a few anterior segments, from a pigeon (sp. ?). Zoological Gardens, Calcutta, collected by the author, 1.2.14.

The hooks measured about 23μ, and were in a double row. The only species with hooks 23μ long are *D. paradisea*, Führ., and *D. conopophilea*, Johnstone. The specimen was mounted.

Davainea sp.

One specimen, from the common pigeon (*Columba* sp.). Zoological Gardens, Calcutta, collected by the author, 11.12.13.

The worm measured 15 cms. long and 3 mm. broad; head absent. The egg capsules extend beyond the water vessels, and each capsule contains three or four oncospheres.

Hymenolepis gracilis, Cohn, 1901

Two specimens, complete, from *Crocopus phoenicopterus*. Chilka Lake, Orissa, India (Chilka Survey), 22.11.14. Not previously recorded from this host.

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C. DUCKS

Hymenolepis sp. (*sinuosa* ?, Zed., 1800), Cohn, 1901
= *T. bairdii* (Krefft, 1871)
= *H. collaris* (Batsch, 1786)

Seven specimens from intestine of *Anas poecilorhyncha*. Zoological Gardens, Calcutta, collected by the author, 6.2.15.

The worms measured 6 to 8 cms. long and the greatest breadth was 2 mm. None of the specimens possessed a head. The posterior segments were as long as broad, and some of the anterior segments were bell-shaped and much longer than broad.

The three testes were lobed. Two were situated on the aporal side, one being directly anterior to the other. The third testis was on the pore side. The ovary was situated between the testis on the pore side and the anterior aporal testis. The accessory sac was well defined.

In the absence of a head, it is impossible to say with certainty to which species our specimens belong, but they bear a very close resemblance to *H. sinuosa* (Zed.).

Drepanidotaenia gracilis (Zed. 1803), Railliet, 1893

Six specimens from a tufted duck (*Fuligula cristata*). Loktak Lake, Manipur, Assam, Station 15, February 22nd, 1920. Manipur Survey, Zoological Survey of India. Recorded for the first time from this host.

Drepanidotaenia fasciata (Rud., 1810), Railliet, 1893

Duck. Intestine. No date or other details. Madras, collected by the author.

Fimbriaria malleus (Goeze, 1782), Froel, 1802

One specimen from a tufted duck (*Fuligula cristata*). Loktak Lake, Manipur, Assam, Station 15, February 22nd, 1920. Manipur Survey, Zoological Survey of India. Recorded for the first time from this host.

Cotugnia (?) *bifaria* (Sieb., 1848), Stiles, 1896

One specimen, 80 mm. long and without head; from a duck (species ?). Zoological Gardens, Calcutta, collected by the author, 4.3.14.

Diploposthe laevis (Bloch, 1782), Jacobi, 1896

1. Three specimens without heads. Collected by the author from *Nyroca fuligula* (the tufted duck); Zoological Gardens, Calcutta, 28.1.16.

The worms measured about 80 mm. long and 5 mm. broad.

2. One complete specimen from *Nyroca baeri* (eastern white-eyed duck). Zoological Gardens, Calcutta, 11.4.11.

The specimen measured about 85 mm. long and 6 mm. broad. Recorded for the first time from this host.

D. CROWS

Genus *Davainea*, Blanchard and Railliet, 1891

Davainea corvina, Führmann, 1905
= *D. polycalcaria*, Linstow, 1906

(*a*) From *Corvus macrorhynchus*

1. Two specimens. Calcutta, India, collected by the author, September, 1912.

2. Two specimens, without heads. Calcutta, India, collected by the author, no date, and numbered Z.E.V. $\frac{6873}{7}$ in the collection of the Indian Museum.

3. Two specimens. Calcutta, India, July 18th, 1911. Numbered Z.E.V. $\frac{5359}{7}$ in the collection of the Indian Museum.

4. Seven specimens. Calcutta, India, collected by the author, 29.9.12.

5. Numerous specimens. Sabour, Bihar, India, collected by the author, 21.10.13.

(*b*) From *Corvus macrorhynchus* and *Corvus splendens*

6. Numerous specimens. Calcutta, India, collected by the author and numbered Z.E.V. $\frac{6146}{7}$ in the collection of the Indian Museum.

(*c*) From *Corvus* sp.

7. Five very large specimens. Khulna. Bengal, collected by the author, 1912.

8. Numerous large specimens. Chilka Lake, Orissa, India, collected by the author, 4.8.13., and numbered Z.E.V. $\frac{6146}{7}$ in the collection of the Indian Museum.

Genus *Hymenolepis*, Weinland, 1858

Hymenolepis dahurica (Linstow, 1903), Führmann, 1906

Three specimens. Calcutta, India, collected by the author and numbered Z.E.V. $\frac{6164}{7}$ in the collection of the Indian Museum. No date.

Cotugnia margareta, Beddard, 1916

One specimen. Calcutta, India, collected by the author, 1913. Both the preceding species were from *Corvus macrorhynchus*.

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E. BIRDS (MISCELLANEOUS)

Davainea urogalli (Modeer), 1790
= *Taenia urogalli*, Modeer, 1790
= *Taenia calva*, Baird, 1853
= *Davainea calvi*, Shipley, 1906

Many specimens (only one with a head) from *Caccabis chucar* (Partridge). Zoological Gardens, Calcutta, India, collected by the author, 18.2.18.

Cittotaenia avicola, Führmann, 1897

One specimen, probably of this species, from the intestine of a moonal pheasant (*Lophophorus refulgens*). Zoological Gardens, Calcutta, India, collected by the author, 6.6.17.

The worm was complete, but in a bad state of preservation; the latter circumstance being due to the fact that the host had been dead over a day when the post-mortem was made. As a result, it was impossible to make out the anatomy with precision. The worm measured 16 cms. long, and many of the posterior segments were longer than broad; the largest measured 3·6 mm. long and 2·8 mm. broad. The head measured from 0·75 mm. to 1 mm. broad.

Anomotaenia acollum, Führmann, 1907

Two specimens from intestine of *Cuculus varius*. Zoological Gardens, Calcutta, India, collected by the author, 20.1.14.

Bertia delafondi (Railliet, 1882), Führmann, 1901
= *T. delafondi*, Railliet, 1882
= *T. sphenocephala* (Megnin, Linstow), *ex parte*

A fragment (mounted) from intestine of *Platycercus pennanti*. Zoological Gardens, Calcutta, India, collected by the author, 25.6.15.

Hymenolepis fusus (Krabbe, 1869), Führmann, 1906

Numerous complete specimens from the intestine of a gull (*Larus brunneicephalus*). Zoological Gardens, Calcutta, India, collected by the author, 30.11.15.

The hooks measured 16μ and were of the shape typical in this species. The neck was long; of the three testes, two were situated on the pore side, one anterior and slightly lateral to the other.

Dilepis macrosphincter, Führmann, 1909

One complete specimen from the intestine of *Ardea purpurea*. Zoological Gardens, Calcutta, India, collected by the author, 20.9.15.

The specimen measured 10 cms. long and the greatest breadth was 1·7 mm. The genital pores are unilateral; the head bore sixteen to eighteen hooks measuring 54μ.

Hymenolepis liguloides (Gerv., 1847), Cohn, 1901
= *Amabalia lamelligera*, Linst., 1879
= *T. caroli*, Paroni, 1887

Two specimens from the intestine of *Phoenicopterus roseus* (flamingo). Zoological Gardens, Calcutta, India, 19.5.19.

Drepanidotaenia megalorchis (Lühe, 1898)

Several specimens from intestine of *Phoenicopterus roseus* (flamingo). Zoological Gardens, Calcutta, India, collected by the author, 16.1.13.

Hymenolepis ? breviannulata, Führmann, 1906

Fragments and one head, probably of this species, from intestine of little cormorant (*Phalacrocorax carbo*). Chilka Lake, Orissa, India. Chilka Survey. No date. Numbered Z.E.V. $\frac{6815}{7}$ in the collection of the Indian Museum.

Davainea cohni, Bacz., 1914.

1. Several specimens from *Pterocles exustus*, Temm., 1825. Zoological Gardens, Calcutta, India, collected by the author, 29.1.15.

2. Six specimens, without heads, the largest measuring 16 cms. long and 1·2 mm. broad, from the intestine of *Pterocles arenarius*. Zoological Gardens, Calcutta, India, collected by the author, 24.11.16.

Choanotaenia (? ungulifera)

Several specimens, without heads, from *Totanus hypolencus* (common sand-piper). Barkuda Island, Chilka Lake. No date.

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F. REPTILES

Family *BOTHRIOCEPHALIDAE*, Cobb., 1864

Sub-family *DIBOTHRIOCEPHALINAE*, Lühe, 1899

Genus *Bothridium*, Blainville, 1824

Bothridium pithonis, Blainville, 1828

1. Four specimens from *Python molurus*, collected by Lt.-Col. Clayton Lane, I.M.S., Darjeeling, Bengal India, 15.3.14.

2. One specimen from *Python reticulata*. Zoological Gardens, Calcutta, India, collected by the author, 26.1.18.

3. Several large specimens from intestine of *Python molurus*. Zoological Gardens, Calcutta, India, 3.7.19.

4. Several large specimens from *Python molurus*, collected by Lt.-Col. Clayton Lane, I.M.S., Berhampur, Bengal, India, May, 1913.

5. Seven very large specimens from *Python reticulata*, collected by Lt.-Col. Clayton Lane, I.M.S., Darjeeling, Bengal, India, 1917. ?

6. Two very large specimens from *Python* sp. Darjeeling, Bengal, India, 1916.

Genus *Duthiersia*, Perrier, 1873

Duthiersia fimbriata (Diesing, 1850), Mont. and Crety, 1891

1. Several specimens from *Varanus salvator*. Outskirts of Calcutta, India. Purchased. No date.

2. Several specimens. Numbered Z.E.V. $\frac{5364\text{-}65}{7}$ and Z.E.V. $\frac{5451}{7}$, from *Varanus salvator*. Zoological Gardens, Calcutta, India, collected by the author, 1914.

3. Four specimens from *Varanus salvator*. Zoological Gardens, Calcutta, India, collected by Dr. Baini Prashad, December, 1920.

4. Two specimens from *Varanus flavescens*. Zoological Gardens, Calcutta, India, collected by the author, 21.6.16.

5. A few badly preserved fragments from *Varanus flavescens*. Zoological Gardens, Calcutta, India, collected by the author, 18.7.15.

6. One specimen and a few fragments from *Varanus* sp.

Berhampur, Bengal, India, collected by Lt.-Col. Clayton Lane, I.M.S. Numbered Z.E.V. $\frac{5508}{7}$ in the collection of the Indian Museum.

7. Five specimens from *Varanus nebulosus*. Zoological Gardens, Calcutta, India, 21.3.19

8. Several specimens from lungs, mesenteries and stomach of *Varanus salvator*. Zoological Gardens, Calcutta, India, collected by the author, 7.2.13.

9. About twelve specimens from *Varanus salvator*. Zoological Gardens, Calcutta, India, collected by the author, 19.4.13.

10. Two large and complete specimens from *Varanus nebulosus*, collected by E. Vredenburg, Esq., Geological Survey of India, 3.7.16.

11. Two small specimens from intestine of *Varanus salvator*. Zoological Gardens, Calcutta, India, collected by the author, 26.3.15.

Family *PROTEOCEPHALALIDAE*, La Rue, 1914

Genus *Acanthotaenia*, Linstow, 1903

Acanthotaenia biroi (Ratz, 1900)
= *Ichthyotaenia biroi*, Ratz, 1900

Numerous specimens from *V. bengalensis*, killed on the shores of the Chilka Lake, Orissa, India, collected by the author, 6.8.13. and numbered Z.E.V. $\frac{6045}{7}$ in the collection of the Indian Museum.

The variations observed in our specimens of this species leave little doubt that it is identical with *A. tidswelli*, Johnston, separated by Johnston on account of the position of the genital pore and the shape of the cirrus pouch. A casual observation led, in the first instance, to the identification of this specimen as *I. nilotica*, Beddard, but it differs from *I. nilotica* in having only about forty-five testes, etc., whilst it agrees in all details with *I. biroi*.

Genus *Ophiotaenia*, La Rue, 1911

Ophiotaenia sp. (*calmetti*, Barrois ?)

Two fragments, measuring about 15 mm. long and 4 mm. broad; immature. No head present. From intestine of *Bungarus coeruleus*. Zoological Gardens, Calcutta, India, collected by the author, 7.2.18.

Genus *Ophidotaenia*, Beddard, 1913

Ophidotaenia naiae, Beddard, 1913

One young but complete specimen from *Naia tripudians*. Zoological Gardens, Calcutta, India, 15.1.21.

The genitalia were fully developed, but the uterus, which consisted of a central stem running antero-posteriorly, was very young and not gravid. The uterine pores, described by Beddard, were therefore not developed, but in every other respect the worm agreed with Beddard's description.

Genus *Linstowia*, Zsch., 1899

Linstowia sp.

Two specimens without heads; from *Hemidactylus flaviviridis*, killed in the grounds of the Indian Museum, Calcutta, India, collected by Dr. Baini Prashad. No date.

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G. AMPHIBIANS

Nematotaenia dispar, Lühe, 1899

1. A few fragments from a toad (*Bufo* sp.), collected by Captain Stewart, I.M.S., 5.2.14.

2. One complete specimen and several fragments from intestine of *Bufo melanostictus*, collected by Captain R. B. Seymour Sewell, I.M.S.

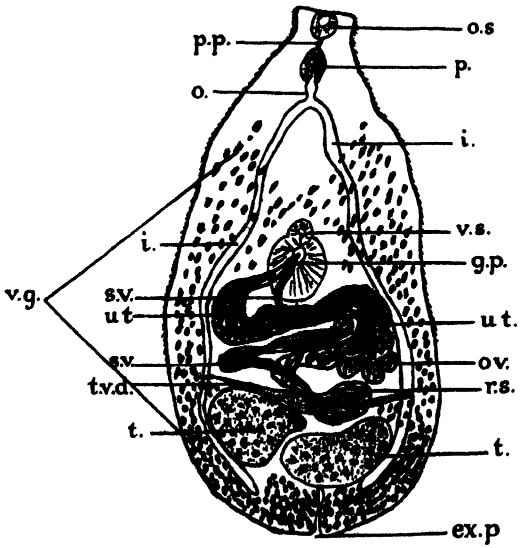
CRYPTOCOTYLE LINGUA (Creplin, 1825), Fischoeder, 1903, IN A DOG IN ENGLAND

BY

P. A. MAPLESTONE

(*Received for publication* 10 *May*, 1922)

Three specimens of this small fluke were recovered from a dog killed in the Dogs' Home, Liverpool.



Cryptocotyle lingua, ventral view. *ex.p.*—excretory pore; *g.p.*—genital pore; *i*—intestine; *o*—oesophagus; *o.s.*—oral sucker; *ov*—ovary; *p*—pharynx; *p.p.*—prepharynx; *r.s.*—receptaculum seminis; *s.v.*—vas deferens and seminal vesicle; *t*—testis; *t.v.d.*—transverse vitelline duct; *ut*—uterus; *v.g.*—vitelline glands; *v.s.*—ventral sucker. × 54.

The following table sets out the principal dimensions and anatomical characters of the three specimens:—

TABLE

	Spec. 1	Spec. 2	Spec. 3
Length and Breadth ...	1·4 × 0·7 mm.	1·3 × 0·67 mm.	1·5 × 0·75 mm.
Oral sucker	108μ	80μ	96μ
Pharynx	76μ	76 × 76μ	72 × 72μ
Oesophagus	80μ	60μ ?	? —
Bifurcation of intestine ...	260μ from anterior end	220μ from anterior end	? —
Genital sucker	—	160μ	148μ
Testes	Right testis anterior	Right testis anterior	Right testis anterior
Ovary	3 lobes in line, 260 × 68μ, on left	4 or 5 lobes grouped together about 120μ across, on left	3 or 4 lobes grouped together about 128μ across, on left
Vitellaria	Meet anterior to ventral sucker. Left side runs as far as gut fork. Right not so far	Nearly meet anterior to sucker and a few follicles about reach gut fork	Do not meet anterior to sucker and do not reach gut fork on either side
Eggs	50 × 30μ	48 × 24μ	48 × 28μ

With the exception of the relative positions of the testes and ovary, the worms closely agree with the full description given by Linton (1915). In Linton's drawing the left testis is figured as lying diagonally in front of the right testis, and the ovary is on the right side. In the present material the reverse is the case, viz., the right testis is slightly in front of the left and the ovary is on the left.

Ransom (1920), in defining the genus *Cryptocotyle*, states: 'Testes near posterior end of body, irregularly oval or globular and usually slightly lobed, or right testis obliquely behind the left. Ovary irregularly oval, or usually lobed, commonly like a clover leaf, situated on the right side of the median line in front of the seminal receptacle.' If this definition is adhered to, it will necessitate placing the present material in a new genus, which does not seem

advisable when it is so close to previously described specimens. The above points seem to be too detailed for generic distinction, especially when it is borne in mind that in other flukes of undoubtedly the same species the positions of testes and ovary frequently vary, and hence in these cases are not even of specific value. For instance, in a collection of *Fasciola hepatica* from one host, although the ovary is usually on the right, occasionally a specimen is found with it on the left; a similar instance has recently been observed by the writer in *Gastrodiscus aegyptiacus* and *Gastrodiscus secundus*. In both these species the testes are diagonally placed and either the left or right testis may be anterior, and the ovary also lies either on the right or left side, being always on the opposite side to the posterior testis (in this genus the ovary is posterior to the testes). The present variation is of exactly the same character, the ovary being on the opposite side to the anterior testis (ovary anterior to testes in the genus *Cryptocotyle*). A further reason against making the side on which the ovary lies of generic value is that Nicoll (1907), in defining the same genus, states: 'Ovary irregularly lobed, on right or left side of middle line.'

It is also apparent from the study of the present specimens that the distribution of the vitellaria is subject to considerable variation, and that Ransom's definition is too restricted in this respect. Ransom's definition, therefore, should be slightly emended so as to allow the inclusion of the present specimens in the species *C. lingua*, which appears preferable to making a new genus on admittedly variable characters.

Occurrence. This worm has been recorded from many fish-eating birds in Europe and North America, and once in the dog by Wigdor (1918), at Detroit, Michigan, U.S.A., as the type of a new genus *Hallum*. Ransom (1920) states that he has examined some of Wigdor's material, and he places the worm in the species *Cryptocotyle lingua*. The discovery of this worm in England makes it appear probable that it is more common in dogs than the record of its occurrence in this host would lead one to suppose, and that it has often been missed on account of its minute size.

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ON THE GENITAL ARMATURE OF THE FEMALE MOSQUITO

BY

J. W. S. MACFIE

AND

A. INGRAM

(*Received for publication* 15 *May*, 1922)

So far as we have been able to ascertain, very little attention has hitherto been paid to the differential characters of the genital armature of female mosquitoes. In this paper, therefore, we record briefly the results of a preliminary examination we have made of fifty West African species referable to sixteen different genera.

It may be said generally that we have found in most cases well marked differences between distinct genera, but only slight or almost inappreciable ones between species of the same genus. The degree of resemblance is, however, very variable: in some genera, as for example in the genus *Stegomyia*, it is very close; in others, much less so. In some genera, indeed, as in the genus *Mimomyia* and the somewhat heterogeneous genus *Ochlerotatus*, there are such notable differences between certain species that they appear to be almost generic.

In making our examinations we have again found pure carbolic acid a valuable reagent. When immersed in this fluid, either with or without previous treatment with caustic potash, the abdomen of a mosquito swells out and becomes transparent, and if mounted under a cover-slip in a hollow on a glass slide, can be rolled over and over, so that every aspect of it can be carefully examined. In fresh or fairly recent preserved specimens, the spermathecae also are expanded by this treatment, so that their precise shape can be determined and accurate measurements made of their various diameters; in old specimens, however, this does not always happen as the spermathecae are collapsed, and may be so much hardened that no procedure which we have hitherto tried will restore their elasticity sufficiently to permit of their subsequent expansion when immersed in carbolic acid.

The figures illustrating this paper are mere outlines, drawn with the aid of a camera lucida, omitting both hairs and scales. It should also be explained that when giving measurements in the text, such as those of the cerci or spermathecae, the length is given first and then the breadth, unless otherwise noted. The following abbrevations are used in the figures.

t viii, t ix.=Tergite of segment eight, nine.
s viii, s ix.=Sternite of segment eight, nine.
c. =Cerci.
v.p. =Ventral process of the tenth segment.
sp. =Spermatheca.

GENERAL MORPHOLOGY OF THE FEMALE ARMATURE

External armature. The eighth abdominal segment is usually of normal form, and has a well developed tergite and sternite; although most commonly distinct, it is sometimes partially, or even almost completely withdrawn within the seventh segment. The ninth segment, which is small and somewhat modified, is more or less withdrawn within the eighth segment, so that there is on the ventral aspect a small membranous recess in the middle of which opens the genital canal. In this recess, in the middle line immediately above the posterior margin of the eighth sternite, there is also in some species, for example in the genus *Culex*, a clearly defined, tuft-like group of stout setae. The ninth tergite is small, and is usually reduced to a narrow transverse strip of chitin bearing a few hairs, but in some genera is rather more highly developed and is shield-shaped. The genital orifice is supported by ventral sclerites which vary considerably in size and form in different species, and which are usually poorly developed. In the neighbourhood of the genital orifice, but internally and projecting forwards and downwards, is also a supporting framework which in a dorsal or ventral view appears as a more or less U-shaped structure surrounding the vulva on its lateral and posterior sides. This structure is well chitinised in some species, especially in the genus *Culex*. The tenth segment is greatly reduced, and is without either tergite or sternite. It bears dorsally the two cerci, which play a part in the manipulation of the eggs, and ventrally a short median process the function of which is apparently unknown. The cerci are more

or less leaf-like structures, and show a great diversity of size and shape. Most commonly they are short and truncated at their ends, somewhat hollowed on their inner surfaces, and set obliquely, so that their upper margins converge and a full-view of them can be obtained only when the abdomen is in a sub-lateral position. The anus opens on a membranous projection between the cerci.

Internal armature. The two ovaries lie one on each side of the abdomen. In recently hatched mosquitoes they are small, but in gravid individuals they occupy the greater part of the lateral and dorsal portions of the abdomen. From each ovary arises a short, wide, muscular oviduct which runs a straight course posteriorly and inwards and meets its fellow of the other side in the middle line to form the common oviduct, a relatively short, wide, muscular tube which lies ventral to the rectum and opens at the genital orifice. Into the common oviduct there opens, a short distance above the genital orifice, the duct of the gluten or mucous gland. This gland is single, and occupies a median ventral position. The spermathecae are situated on the ventral aspect of the eighth segment, and are highly chitinised oval or sub-spherical bodies enclosed in a thick cellular envelope. The chitinised wall is usually more or less pitted with small round or oval areas of thinner chitin which are most commonly grouped round the point of origin of the duct, but may be distributed over the whole surface of the spermathecae. When the spermathecae are viewed by transmitted light these areas appear as light-coloured marks, and are, therefore, referred to as 'pale spots' in the specific descriptions which follow. The ducts of the spermathecae are long and coiled, and open into the common oviduct just before the genital orifice. They are usually chitinised for a short distance only at their commencement, and for the greater part of their length appear to be muscular with an inner lining somewhat resembling a tracheal tube. In those species which have three spermathecae, the middle one is usually the larger and has an independent duct. The ducts of the lateral spermathecae unite about their middles to form a common duct which opens into the common oviduct close to, but apparently not actually in common with the duct of the middle spermatheca. The extremity of the duct of the middle spermathecae may be chitinised for a short distance before entering the common oviduct.

Sub-family *CULICINAE*

Tribe ANOPHELINI

Genus *Anopheles*

Eight species were examined, all of which possess genitalia of a somewhat similar form. There is in each case a single, large, highly chitinised spermatheca which is sub-spherical in shape, the length being but slightly greater than the breadth. The duct of the spermatheca, which is chitinised for a short distance, arises obliquely, thus forming an acute angle with one side of the body of the spermatheca On this side, especially near the distal pole and around the base, the chitinous wall of the spermatheca is pitted with

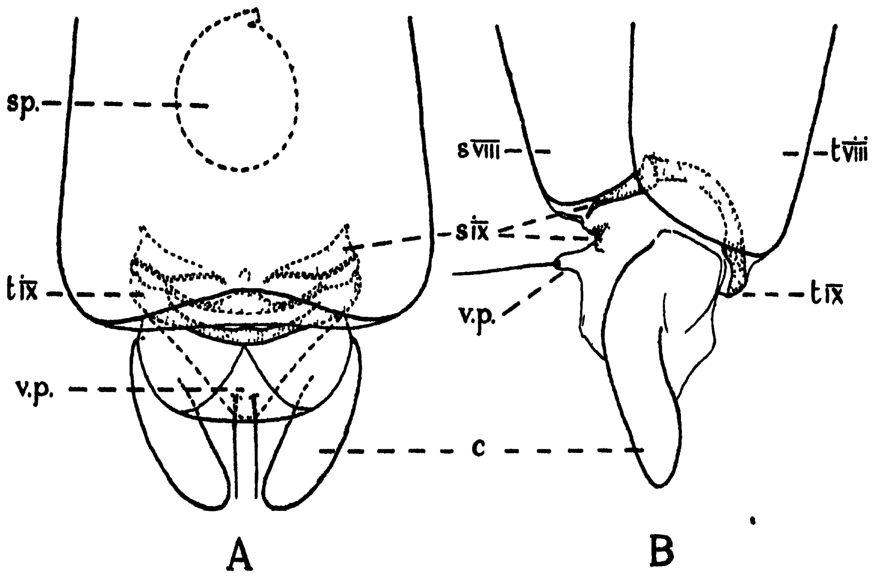

FIG 1 *Anopheles costalis*, Theo, posterior extremity of abdomen of female *A*—dorsal view, *B*—lateral view × c 185

numerous round or oval areas which by transmitted light appear as pale spots. The form of the spermatheca and the distribution of these pale spots furnish differential points in some species, as also do the characters of the cerci.

A. costalis, Theo. (fig. 1). Twenty specimens. Posterior extremity of the abdomen blunt, cerci prominent. The eighth segment not retracted within the seventh, sternite not notched in the

middle line posteriorly. The ninth segment retracted within the eighth, its tergite reduced to a narrow strip of chitin, and its sternite represented by two transverse bars of chitin which are roughly triangular in shape with their apices directed towards the middle line and a more posterior bar which is broadest in the middle line. Cerci (fig. 2 *d*) elongate-ovoid with blunt, rounded ends; length

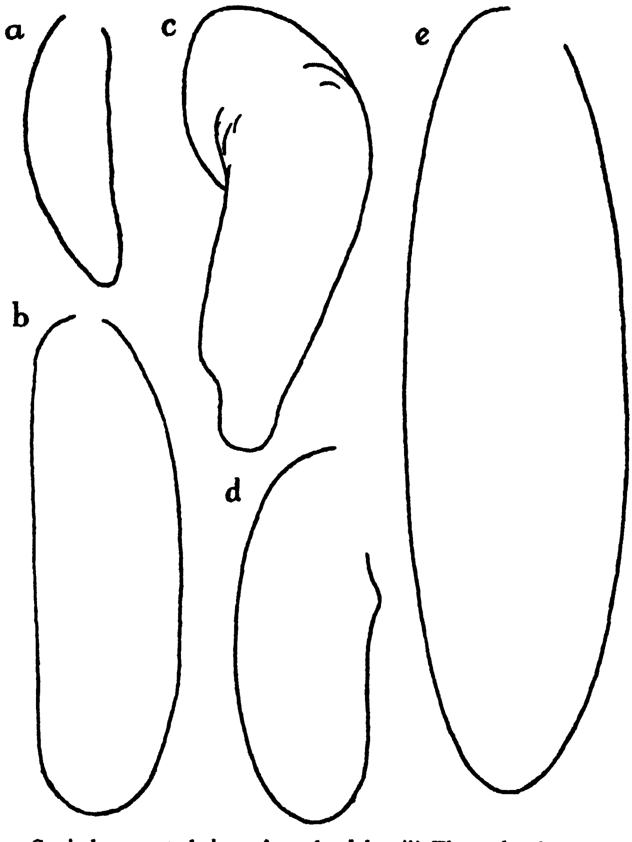

FIG. 2. Cerci, dorso-ventral views of *a*—*Anopheles nili*, Theo.; *b*—*A. squamosus*, Theo.; *c*—*A. mauritianus*, Grp.; *d*—*A. costalis*, Theo., and *e*—*A. pharoensis*, Theo. × c. 375.

varying from 122μ to 167μ, average 140μ; breadth from 30μ to 62μ, average 51μ. Ventral process on the tenth segment small, triangular, not emarginate, bearing two stout bristles near its apex. Spermatheca (fig. 3 *a*) single, large, sub-spherical, the length, which varied from 95μ to 133μ, average 118μ, being slightly greater than the breadth, which varied from 95μ to 130μ, average 112μ. It is

well chitinised but has numerous small round or oval areas of thinner chitin, which by transmitted light appear as pale spots, at the base and along one side, namely, the side towards which the duct projects. The duct arises obliquely, and the chitinised portion of it, which is very short and shows a few pale spots, forms an acute angle with the spermatheca; the chitinised wall of the duct lying next to the body of the spermatheca measured from 8μ to 19μ, average 13μ.

A. marshalli, Theo. One specimen. Generally similar to *A. costalis*. Cerci rather shorter and relatively broader, elongate-ovoid, with blunt, rounded ends; length about 100μ, breadth about 40μ. Spermatheca (fig. 3 *b*) slightly smaller, diameter about 95μ;

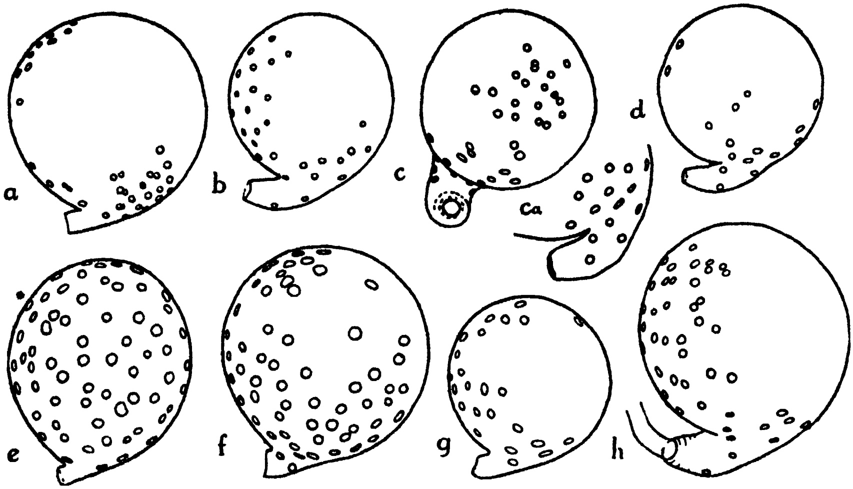

FIG. 3. Spermathecae of *a*—*Anopheles costalis*, Theo.; *b*—*A. marshalli*, Theo.; *c* and *ca* — *A. funestus*, Giles; *d*—*A. nili*, Theo.; *e*—*A. mauritianus*, Grp.; *f*—*A. pharoensis*, Theo; *g*—*A. squamosus*, Theo., and *h*—*A. rufipes*, Gough. × c. 250.

distribution of pale spots much as in *A. costalis*; the chitinised portion of the duct longer, about 18μ, somewhat curved and slightly constricted at its end.

A. funestus, Giles. Eight specimens. Generally similar to *A. costalis*. Cerci rather more slender; length varying from 95μ to 120μ, average 108μ, breadth from 27μ to 36μ, average 32μ. Spermatheca (fig. 3 *c* and *ca*) varying in length from 91μ to 105μ, average 98μ, and in breadth from 84μ to 100μ, average 93μ; pale spots somewhat larger, but arranged much as in *A. costalis*;

chitinised portion of the duct long, varying from 34μ to 47μ, average 40μ; curved and slightly constricted at the end.

A. nili, Theo. Two specimens. Generally similar to *A. costalis*. Cerci (fig. 2 *a*) smaller and narrower; length about 105μ, breadth about 30μ, and distal extremities more conical than rounded. Spermatheca (fig. 3 *d*) 90μ to 108μ in diameter; pale spots fewer and less distinct; chitinised portion of the duct long, 30μ to 50μ, somewhat curved and slightly constricted at its end.

A. mauritianus, Grp. Two specimens. Generally similar to *A. costalis*, but more highly chitinised. Cerci larger and of peculiar form (see fig. 2 *c*); length about 180μ, breadth in the middle about 50μ. Spermatheca (fig. 3 *e*) somewhat longer than broad, the diameters in two specimens measuring 95μ and 85μ, and 114μ and 96μ respectively; pale spots large, conspicuous, and scattered over the whole surface of the spermatheca; chitinised portion of the duct very short, similar to that of *A. costalis*, but shorter.

A. pharoensis, Theo. Two specimens. Generally similar to *A. costalis* but more highly chitinised. Cerci (fig. 2 *e*) very large, elongate-ovoid; length nearly 300μ, breadth about 80μ; Spermatheca (fig. 3 *f*) highly chitinised, almost spherical, diameter about 110μ; pale spots large, conspicuous, covering two-thirds of the surface; chitinised portion of the duct very short, similar to that of *A. mauritianus*.

A. squamosus, Theo. One specimen. Generally similar to *A. costalis* but more highly chitinised. Cerci (fig. 2 *b*) rather large, elongate-ovoid, with rounded ends; length about 180μ, breadth about 50μ. Spermatheca (fig. 3 *g*) similar to that of *A. costalis* but slightly smaller (diameter 90μ) in the single specimen examined, and with the pale spots larger; chitinised portion of the duct as in *A. costalis*.

A. rufipes, Gough. Two specimens. Generally similar to *A. costalis* but more highly chitinised. Cerci similar to those of *A. funestus*; length 130μ to 150μ, breadth 30μ to 50μ. Spermatheca (fig. 3 *h*) sub-spherical, very highly chitinised; length 130μ to 140μ, breadth 115μ to 118μ; pale spots as in *A. costalis* but rather larger; chitinised portion of the duct long, about 35μ, curved and slightly constricted at its end.

The eight species examined fall naturally into two groups: four

species, namely, *A. costalis*, *A. mauritianus*, *A. pharoensis* and *A. squamosus*, having only a very short portion, and four, namely, *A. marshalli*, *A. funestus*, *A. nili* and *A. rufipes*, having a considerably longer portion of the duct of the spermatheca chitinised. The species belonging to the first group can readily be distinguished by the arrangements of the pale spots on the spermatheca and by the form of the cerci. The species belonging to the second group can hardly be distinguished by these characters, although small differences between them may be noted, such as the large size of the spermatheca in *A. rufipes*, the feeble development of the pale spots and the rather narrow end to the cerci in *A. nili*, and the rather short and broad cerci in *A. marshalli*.

Tribe MEGARHININI

Genus *Toxorhynchites*

T. brevipalpis, Theo. One specimen. Posterior extremity of the abdomen blunt, cerci scarcely projecting; eighth segment not retracted. Sternite and tergite of the ninth segment highly chitinised, each appearing in a ventral view as a strip of chitin bent in the form of an arch with the opening directed anteriorly. Cerci (fig. 4) relatively small, with hatchet-shaped ends; length nearly

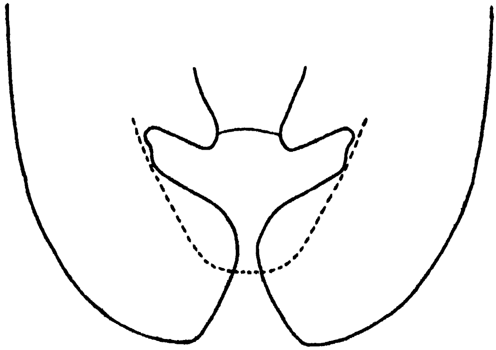

FIG. 4. *Toxorhynchites brevipalpis*, Theo., outlines of cerci and (dotted line) ventral process of the tenth segment, dorsal view. × c. 185.

300μ, breadth 114μ at the widest part. Ventral process of the tenth segment bluntly conical, not emarginate, covered with bristles, none of which are, however, exceptionally long. Spermathecae three,

relatively small, highly chitinised, sub-spherical, the middle one rather larger than the other two, diameter about 110μ; only the very commencement (about 3μ) of the duct is chitinised.

Tribe CULICINI

Genus *Mucidus*

M. scatophagoides, Theo. (fig. 5 A). Two specimens. Posterior extremity of the abdomen tapering; the eighth segment sometimes completely withdrawn within the seventh. Sternite of the eighth

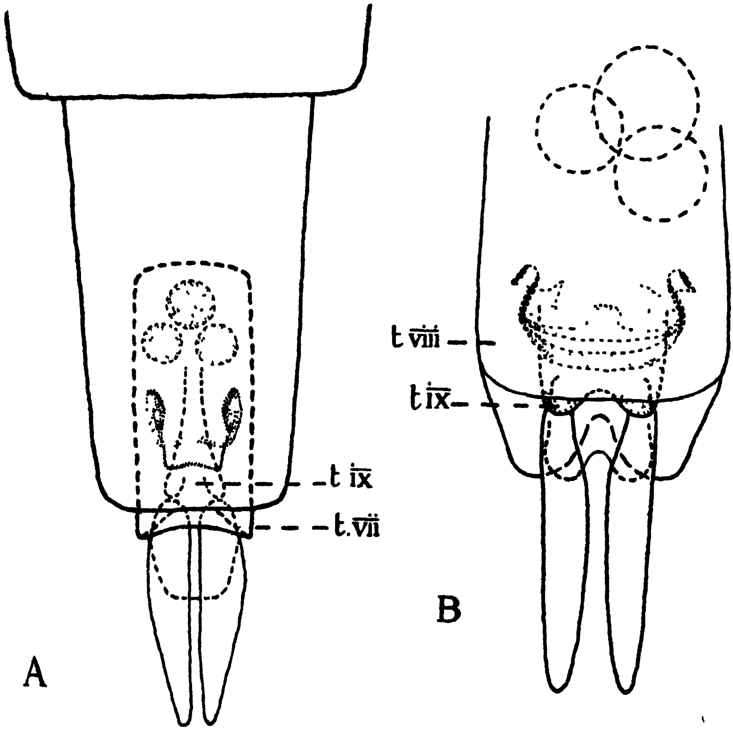

FIG. 5. Posterior extremity of abdomen of female, dorsal view. *A—Mucidus scatophagoides*, Theo. × c. 92; *B—Banksinella lineatopennis*, Lud. × c. 185 *t* viii and *t* ix—tergites of eighth and ninth segments.

segment deeply cleft posteriorly. Sternite of the ninth segment apparently reduced to narrow bands of chitin forming a double U-shaped loop. Cerci very long and leaf-like, tapering towards the

tips, length about 350μ, breadth about 100μ. At the bases of the cerci lies a long, straight plate of chitin, about 250μ in length, which is produced at its posterior end into two hairy lateral processes, runs directly anteriorly, and tapers gradually. This plate is apparently the ninth tergite. Ventral process on the tenth segment tongue-shaped, bearing a few stout setae, posterior margin broad, not emarginate. Spermathecae three, highly chitinised, sub-spherical or oblate-spheroidal, unequal, the middle one being slightly the largest. In the two specimens examined the diameters of the spermathecae were approximately 65μ, 76μ, 65μ, and 74μ, 93μ, 74μ respectively. The ducts of the spermathecae are chitinised only at their very commencement (about 2μ).

Genus *Banksinella*

B. lineatopennis, Lud. (fig. 5 B). Three specimens. Genitalia of similar type to those of the genus *Stegomyia*. Posterior extremity of the abdomen tapering; the eighth segment may or may not be withdrawn within the seventh. Sternite of the eighth segment deeply notched posteriorly; tergite and sternite of the ninth segment relatively well developed. Cerci long, leaf-like, tapering towards their tips, somewhat similar to those of *Mucidus scatophagoides*; length about 220μ, breadth about 60μ. Ventral process of the tenth segment deeply notched in the middle line posteriorly. Spermathecae three, highly chitinised, sub-spherical (the length being slightly greater than the breadth), and unequal. The right and left spermathecae are about the same size, their diameters being about 60μ; the middle one is larger, diameter about 80μ. The ducts of the spermathecae are chitinised for only a very short distance (1μ to 2μ) at their commencements.

Genus *Stegomyia*

Eight species were examined, all of which possess genitalia of a similar form; indeed, so close were the resemblances, that we were in most cases unable to detect differential points, and such differences as were noted appeared to be of only minor importance.

S. fasciata, F. (fig. 6). Ten specimens. Posterior extremity of the abdomen tapering slightly. Eighth segment not, or but slightly withdrawn within the seventh; sternite projecting beyond the

tergite and deeply notched in the middle line posteriorly. Tergite of the ninth segment shield-shaped, the posterior margin produced laterally into conical processes, which are well chitinised and armed with several stout setae. Sternite of the ninth segment represented by a narrow posterior strip of chitin which is arched so that its

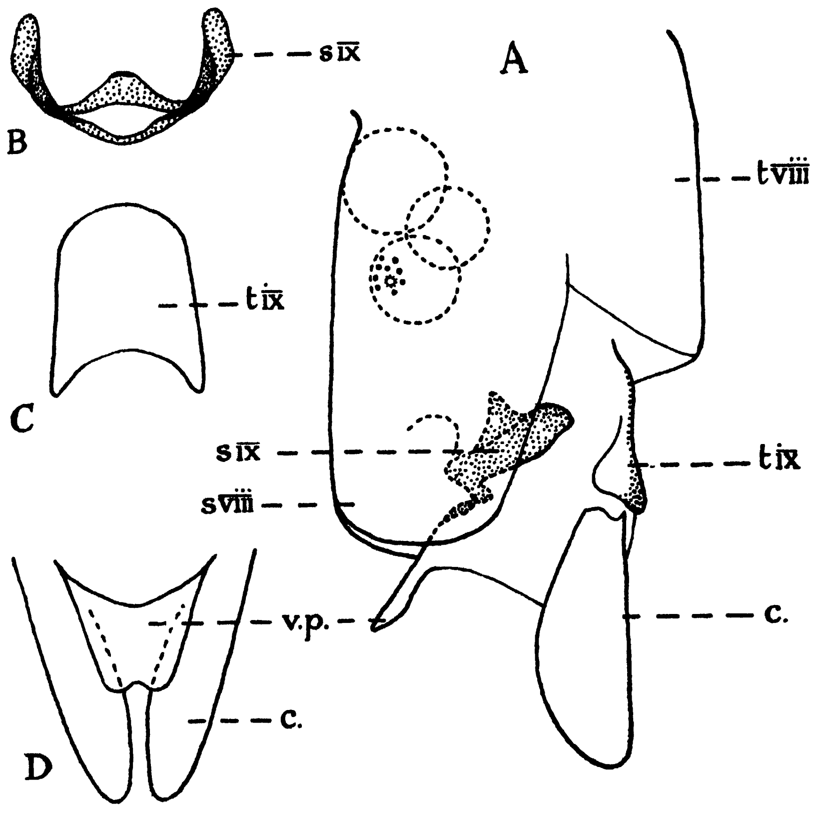

FIG. 6. *Stegomyia fasciata*, F. *A*—posterior extremity of body, lateral view; *B*—ninth sternite, ventral view; *C*—ninth tergite, dorsal view; *D*—cerci and ventral process of tenth segment, ventral view. × c. 185. *t* viii and *t* ix—tergites of eighth and ninth segments; *s* viii and *s* ix—sternites of eighth and ninth segments; *c*—cerci; *v.p.*—ventral process of the tenth segment.

concavity is anterior and is expanded laterally, and a more delicate bar of chitin in front of it, which is broadest in the middle line. Cerci prominent, short and broad, hollowed out on their inner aspects, and inserted obliquely, that is with their broad surfaces converging dorsally; in the ten specimens measured the length

ranged from 152μ to 198μ, average 183μ, and the breadth from 77μ to 103μ, average 85μ. Ventral process of the tenth segment (fig. 7 *a*) with a moderately well developed notch in the middle of its posterior border, and bearing on each side several (about eight) long setae. Spermathecae three, highly chitinised, sub-spherical, the length being usually slightly greater than the breadth. The spermathecae are unequal and somewhat variable in size; the right and left ones are approximately the same size and in the ten specimens measured ranged in length from 61μ to 80μ, average 69μ, and in breadth from 56μ to 76μ, average 63μ; the middle one is larger and ranged in length from 84μ to 95μ, average 91μ, and in breadth from 70μ to 91μ, average 82μ. A few pale spots similar to those in *Anopheles costalis* are sometimes present round the base. The ducts of the spermathecae are scarcely at all chitinised, at most for a distance of 2μ to 4μ at their commencement.

a b c d

FIG 7 Ventral process of the tenth abdominal segment, ventral view, of *a—Stegomyia fasciata*, F, *b—S unilineata*, Theo., *c—S vittata*, Bigot, and *d—Ochlerotatus albocephalus*, Theo. × c. 250

S. apicoargentea, Theo. One specimen Very closely resembling *S. fasciata* In the single specimen examined the only differences noted were that the setae on the posterior angles of the ninth tergite appeared to be longer, that the ventral process of the tenth segment was less deeply notched, and that the spermathecae were rather large, measuring 84μ by 80μ, 110μ by 91μ, and 80μ by 76μ These slight differences may be merely variations, and without confirmation from more materials are insufficient to distinguish the species

S dendrophila, Edw. Two specimens. Apparently indistinguishable from *S. fasciata*.

S. luteocephala, Newst. Four specimens. Very similar to *S. fasciata*, the only difference noted being the absence of the notch in the posterior border of the ventral process of the tenth segment.

S. metallica, Edw. One specimen. Apparently indistinguishable from *S. fasciata*, but notch in posterior border of the ventral process of the tenth segment shallow, as in *S. unilineata*.

S. simpsoni, Theo. One specimen. Apparently indistinguishable from *S. fasciata*, but the notch in the posterior border of the ventral process of the tenth segment is very shallow in the single specimen examined.

S. unilineata, Theo. Six specimens. Apparently indistinguishable from *S fasciata*, but the notch in the posterior border of the ventral process of the tenth segment very shallow (fig. 7 *b*), as in *S. simpsoni* but cerci shorter.

S. vittata, Bigot. Three specimens. Very similar to *S. fasciata*, but the ventral process of the tenth segment long, tongue-like, without a notch (fig. 7 *c*).

Genus *Ochlerotatus*

Five species were examined; in all of them the genitalia were somewhat of the same type as those of species of *Stegomyia*. Two of the species, however, showed a remarkable divergence, inasmuch as they possessed only a single, large, spermatheca.

O. albocephalus, Theo. Two specimens. Similar to *S. fasciata*, but eighth segment usually more or less retracted within the seventh, eighth sternite more widely notched, cerci rather longer and narrower, length about 190μ, breadth about 63μ, ninth tergite smaller, less highly chitinised, notch in the posterior border of the ventral process of the tenth segment much deeper (fig. 7 *d*), and chitinised portion of the ducts of the three spermathecae a little longer, about 4μ to 7μ.

O. apicoannulatus, Edw. One specimen. Similar to *O. albocephalus*, but cerci relatively shorter and broader, length 134μ, breadth 65μ in the single specimen examined, and spermathecae (especially the middle one) a little larger but still well within the range of variation found in *S. fasciata*.

O. domesticus, Theo. One specimen. Similar to *O. albocephalus*, but eighth sternite more deeply notched, cerci longer, length about 280μ, breadth about 68μ, and notch in the ventral process of the tenth segment less deep.

O. irritans, Theo. (fig. 8). Seven specimens. General characters similar to those of *O. albocephalus*. Eighth segment usually partially withdrawn within the seventh, but capable of complete protrusion, disclosing a wide membranous junction between the two segments. Eighth sternite slightly longer than the tergite, notch rather shallow. Cerci of usual form: average length 186μ, average breadth 83μ.

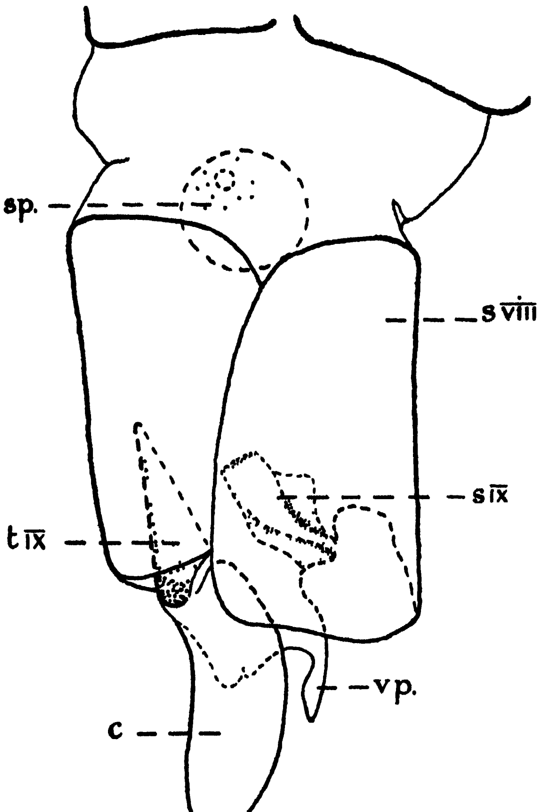

FIG. 8. *Ochlerotatus irritans*, Theo., posterior extremity of abdomen of female, lateral view. × c. 185.

Ventral process of the tenth segment deeply notched posteriorly, as in *O. albocephalus*. Spermatheca single, large, sub-spherical; average length 93μ, breadth 89μ There are at the base a number of pale spots, as in *A. costalis* Duct chitinised for only a short distance, about 5μ, at its commencement.

O. punctothoracis, Theo. One specimen. Apparently almost indistinguishable from *O. irritans*, but the cerci are rather smaller in the single specimen examined and are more pointed at their tips.

Genus *Mansonioides*

M. africanus, Theo. (figs. 9 and 10). Eight specimens. Posterior extremity of the abdomen bluntly conical. Eighth segment may be partially retracted within the seventh, tergite narrow, posterior margin armed with a row of strong recurved teeth arranged as shown in the figure (fig. 9), the middle group composed of seven, or more commonly nine teeth, the central one being the longest, the two lateral groups of from five to seven teeth; sternite much longer than the tergite, and prolonged on each side posteriorly as a wide flap which is deeply notched. Ninth segment much reduced, the tergite represented by a narrow arch of chitin, and the sternite by the usual transverse sclerites, which are rather poorly developed. Cerci rather short with their narrowest diameter directed dorso-ventrally, slightly concave dorsally, and ending in a rather sharp tip; length variable, average about 192μ, middle lateral breadth about 90μ. Ventral process of the tenth segment very deeply cleft in the middle line posteriorly. Spermathecae three, two large and very highly chitinised, and one very small and feebly chitinised. The two large spermathecae are sub-equal and sub-spherical; average length 137μ, breadth 125μ. They have a slight bulge near the point of origin of the duct (fig. 13 A), and there are numerous small pale spots at the base. The ducts are chitinised for only a short distance (about 10μ) at the commencement. The small spermatheca is sub-spherical, length about 29μ, breadth about 28μ, it is usually feebly and incompletely chitinised, its base being membranous, and is difficult to find if the abdomen is incompletely cleared, and may for this reason be overlooked. Its duct joins the duct of one of the large spermathecae, so that it clearly represents an ill-developed lateral spermatheca.

M. uniformis, Theo. Five specimens. As in *M. africanus*, but the lateral flaps of the eighth sternite are not notched. In the five specimens examined it was also noted that the teeth in the lateral groups on the dorsum of the eighth segment were rather more variable and numbered from three to six, and that the small

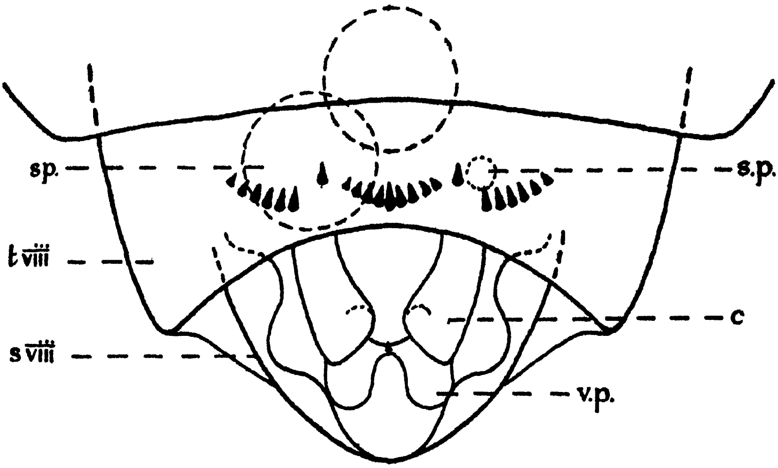

FIG. 9. *Mansonioides africanus*, Theo., posterior extremity of abdomen of female, dorsal view. × c. 150.

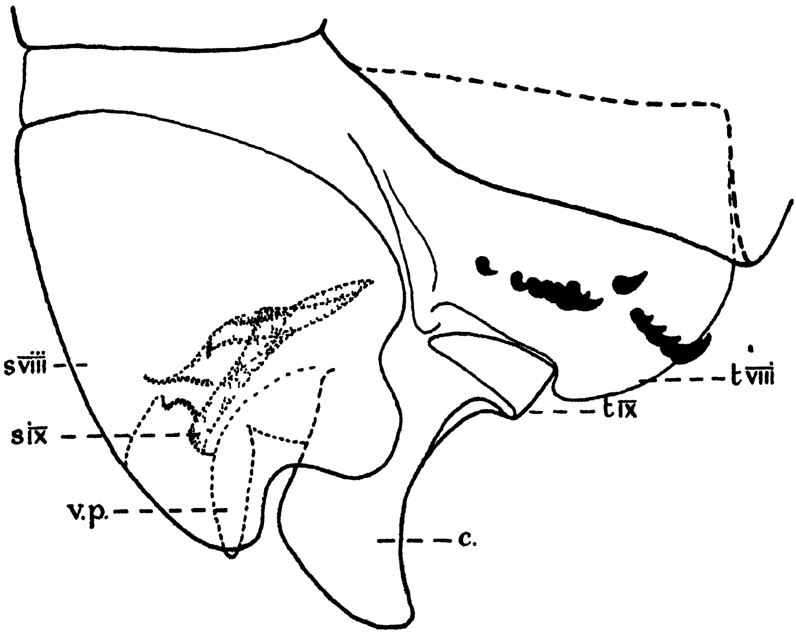

FIG. 10. *Mansonioides africanus*, Theo., posterior extremity of abdomen of female, lateral view. × c. 150.

spermatheca was sometimes rather large, in one instance measuring 65μ by 53μ; these latter differences are probably not specific.

Genus *Aedomyia*

Aedo. africana, Nev.-Lem. (figs. 11 and 12). Two specimens. Similar to *Anopheles*. Posterior extremity of the abdomen blunt,

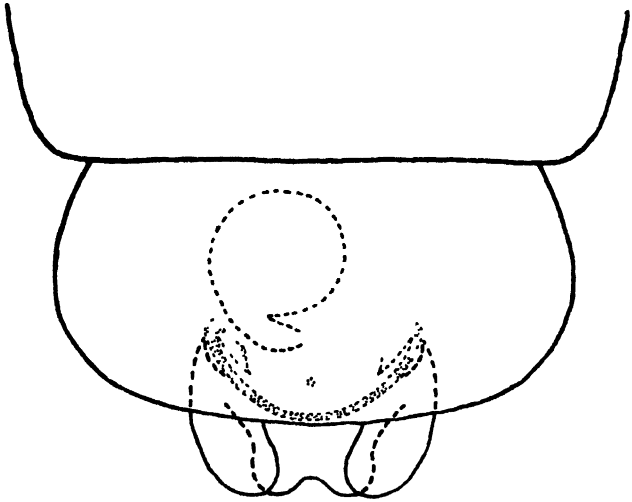

FIG. 11. *Aedomyia africanus*, N. L., posterior extremity of abdomen of female, dorsal view. × c. 185.

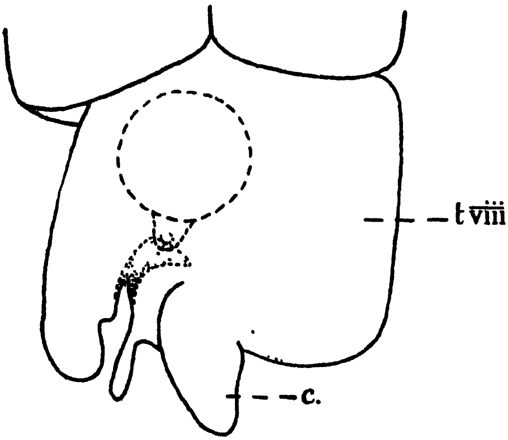

FIG. 12. *Aedomyia africanus*, N. L., posterior extremity of abdomen of female, lateral view. × c. 185.

cerci not prominent. Eighth segment not withdrawn within the seventh; sternite with a shallow notch. Ninth segment much reduced, feebly chitinised. Cerci short and broad, with blunt, rounded ends; length 118μ, breadth 65μ. Ventral process of the tenth segment short and broad with a wide notch in its posterior border, bearing on each side several stout setae. Spermatheca single, very highly chitinised, resembling that of *A. funestus*; length 106μ, breadth 97μ, length of the chitinised portion of the duct 45μ; the whole spermatheca is sparsely dotted with pale spots, which, however, are small and are most numerous at the base.

Genus *Taeniorhynchus*

T. aurites, Theo. (fig. 13, B to D). One specimen. In some respects similar to *Mansonioides*. Eighth segment only slightly withdrawn from the seventh and capable of complete protrusion; sternite long, not notched, tergite short, without teeth. Ninth segment reduced, much as in *Mansonioides*. Cerci (fig. 13 B and C)

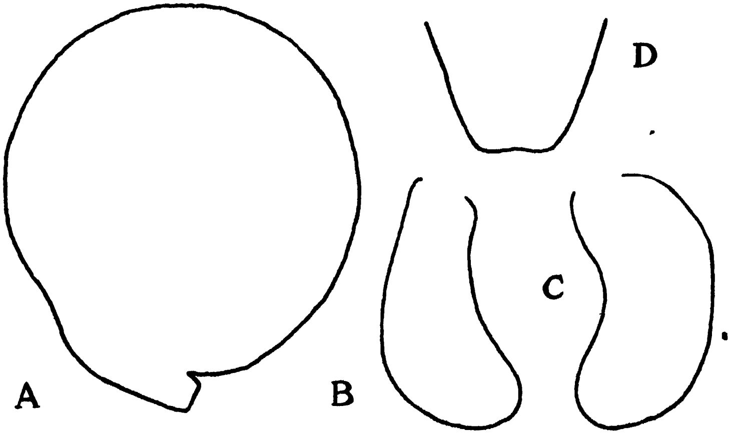

FIG. 13. *A—Mansonioides africanus*, Theo., spermatheca; × c. 375. *B—Taeniorhynchus aurites*, Theo., outline of one of the cerci in ventral view, and *C*—in lateral view; and of *D*—ventral process of the tenth segment; × c. 185.

curved dorsally, short, broad, with rounded extremities; length 182μ, breadth 80μ. Ventral process of the tenth segment hardly at all notched in the middle line posteriorly (fig. 13 D). Spermathecae three, rather poorly chitinised, sub-spherical, large, unequal; in the single specimen examined they were not fully expanded, but, so far

as could be judged, their diameters were respectively about 100μ, 115μ, and 122μ. A short portion of the commencement of the ducts is feebly chitinised.

Genus *Culex*

Twelve species were examined, all of which possess genitalia of a very similar form, so that points of distinction, when found, are but slight and sometimes difficult to detect. In all the species the posterior extremity of the abdomen is blunt, the eighth sternite notched posteriorly, and the cerci relatively small, short, broad, and obliquely set. On the lining membrane, just below the posterior border of the eighth sternite, is a tuft-like group of more or less stout setae. The U-shaped structure surrounding the vulva is well chitinised. The ventral process of the tenth segment is short, occasionally notched, and not very hairy. There are three spermathecae, which are usually oval, and their ducts are chitinised for only a short distance. Points of distinction between species appeared to be furnished by all the above structures. It may be mentioned here that the species belonging to the Genera *Culiciomyia*, *Eumelanomyia*, and *Micraedes*, which we have examined, also possess genitalia of the same type.

C. fatigans, Wied. (figs. 14 and 15). Ten specimens. Posterior extremity of the abdomen blunt, cerci not very prominent. Eighth segment not withdrawn within the seventh, sternite prolonged posteriorly beyond the tergite, and shallowly notched. From the middle of the membrane lining the posterior border of the eighth sternite arises a tuft-like group of about ten rather stout setae. Ninth segment, as usual, much reduced; tergite a narrow strip, broadest laterally and rather feebly chitinised. Ventrally there is a horseshoe-shaped strip of chitin, open anteriorly, enclosing the vulva, and just posterior to it a wider arch of chitin, from the lateral portions of which rather broad but feebly chitinised plates project inwards. Cerci set slightly obliquely, concave internally, short and broad, with truncated ends; in the ten specimens measured, length from 137μ to 170μ, average 150μ, and breadth from 80μ to 91μ, average 85μ. Ventral process of the tenth segment (fig. 17 *b*) without a notch, bearing at its apex a few stout setae, and on the ventral aspect a few (two or three on each side) smaller ones.

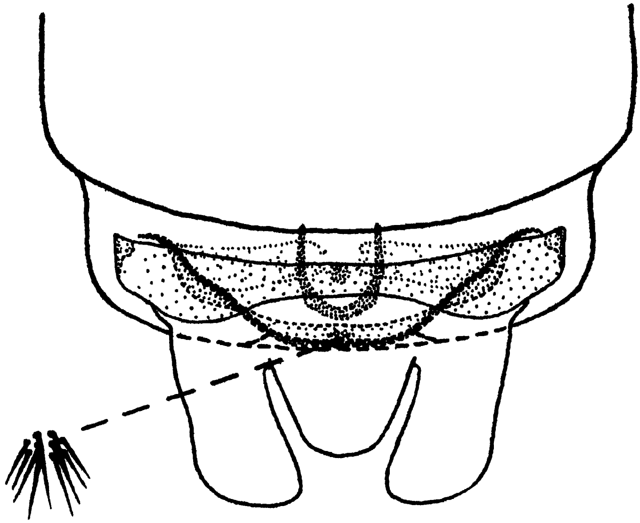

FIG. 14. *Culex fatigans*, Wied., posterior extremity of abdomen of female, dorsal view. × c. 185.

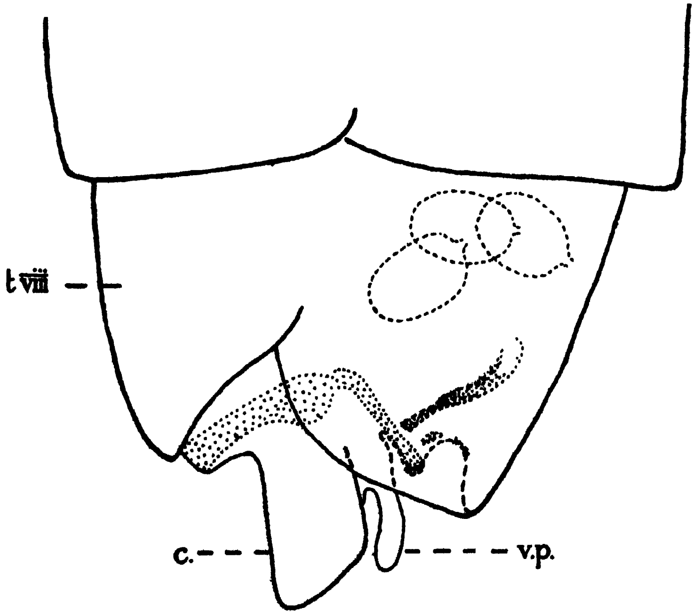

FIG. 15. *Culex fatigans*, Wied., posterior extremity of abdomen of female, lateral view. × c. 185.

Spermathecae (fig. 16 *c*) three, very highly chitinised, sub-equal, the middle one being slightly the largest; in the ten specimens measured the length ranged from 72μ to 99μ, average 84μ, and the breadth from 55μ to 76μ, average 63μ. They are somewhat variable in shape but are usually oval, sometimes almost sub-spherical, and commonly the base is rather broad and the apex narrowed so that they resemble a bee-hive. At the base there are a few 'pale spots.' The chitinised portion of the ducts is short, conical, and in the specimens measured ranged in length from 6μ to 11μ, average 8μ.

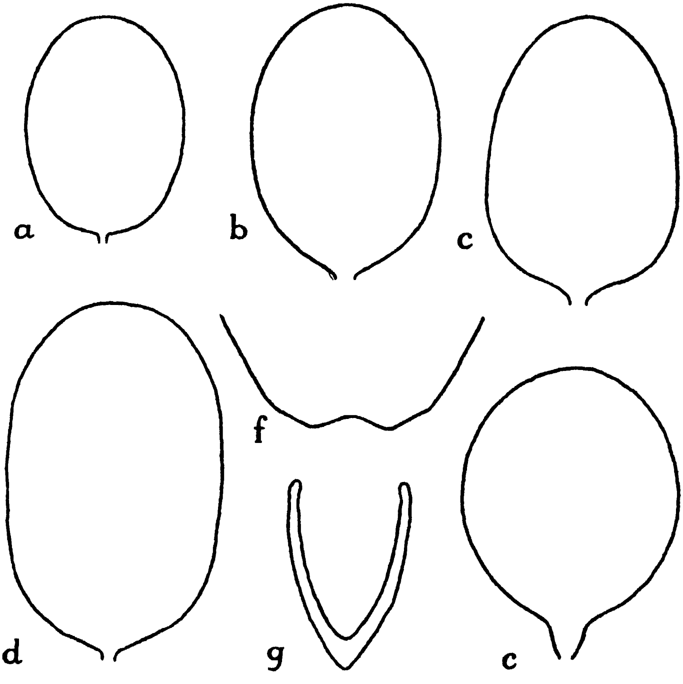

FIG. 16. Outlines of spermathecae of *a*—*Culex insignis*, Cart.; *b*—*C. annulioris*, Theo.; *c*—*C. fatigans*, Wied.; *d*—*C. consimilis*, Newst., and *e*—*C. duttoni*, Theo.; and of *f*—the ventral process of the tenth segment, and *g*—the chitinous hoop round the vulva, of *C. annulioris*, Theo. All × c. 375.

C. annulioris, Theo. One specimen. As in *C. fatigans*, but the inner chitinous bar enveloping the vulva (fig. 16 *g*) is narrower, almost V-shaped, and the ventral process of the tenth segment is shallowly notched and bears four or five small setae on each side on its ventral aspect (fig. 17 *d*). The spermathecae (fig. 16 *b*) are

highly chitinised, sub-equal, oval; length 99μ, breadth 68μ, the chitinised portion of the ducts very short, about 2μ.

C. consimilis, Newst. One specimen. As in *C. fatigans*, but the spermathecae are rather larger (fig. 16 *d*). They are highly chitinised, a rather long, oval shape, and not narrowed at the apex; in the specimen examined the middle one measured 137μ in length by 84μ in breadth, and the chitinised portion of its duct was about 7μ long, and in the other two spermathecae the corresponding

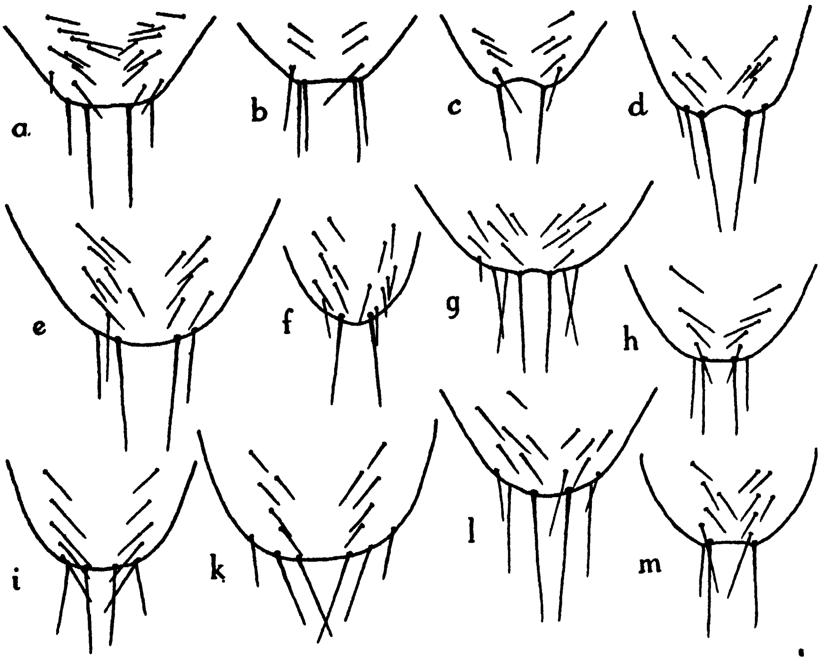

FIG. 17. Ventral process of the tenth segment, ventral view of *a*—*Culex consimilis*; *b*—*C. fatigans*; *c*—*C. decens*; *d*—*C. annulioris*; *e*—*C. duttoni*; *f*—*C. insignis*; *g*—*C. pruina*; *h*—*C. quasigelidus*; *i*—*C. rima*; *k*—*C. thalassius*; [*l*—*C. tigripes* var. *fuscus*; and *m*—*C. tritaeniorhynchus*. × 250.

measurements were 129μ, 80μ, and 4μ respectively. The ventral process of the tenth segment (fig. 17 *a*) is more hairy than in *C. fatigans*, and bears about nine small setae on each side on its ventral aspect.

C. decens, Theo. Twelve specimens. Similar to *C. fatigans*, but in the specimens examined the cerci were rather more prominent, length about 160μ, breadth about 70μ; the tuft of setae on the lining

membrane of the posterior end of the eighth sternite usually rather larger, composed of about a dozen setae; chitinous loop enclosing the vulva not so wide, more U-shaped; the ventral process of the tenth segment (fig. 17 *c*) with a shallow notch, small setae on ventral aspect rather variable, from three to nine on each side; and the spermathecae not so highly chitinised, a little larger, average length 90μ, breadth 68μ.

C. duttoni, Theo. Two specimens. Generally similar to *C. fatigans*. Tuft of setae on the lining membrane of the eighth sternite rather larger, composed of twelve setae; and ventral process of tenth segment (fig. 17 *e*) more hairy, bearing about six to nine small setae on each side on its ventral aspect. Cerci short and broad; length about 175μ, breadth about 115μ. Spermathecae (fig. 16 *e*) very highly chitinised, sub-spherical, the middle one slightly the largest; average length about 85μ, average breadth about 77μ, the chitinised portions of the ducts conical, rather long, average length about 15μ.

C. insignis, Carter. One specimen. Generally similar to *C. fatigans*. Eighth sternite more deeply notched posteriorly; and ventral process of the tenth segment (fig. 17 *f*) more conical and more hairy, bearing about six or seven small setae on each side on its ventral aspect. Chitinised bar encircling the vulva rather strong and thick, and omega-shaped. Tuft of setae on the lining membrane of the eighth sternite rather small, composed of eight setae. Cerci rather small and curved dorsally; length 114μ, breadth 57μ. Spermathecae (fig. 16 *a*) very highly chitinised, oval, the middle one measuring about 95μ by 68μ, and the lateral ones 84μ by 57μ; the chitinised portion of the ducts is short (5μ to 6μ) and narrow (4μ).

C. pruina, Theo. One specimen. Apparently almost indistinguishable from *C. fatigans*, but in the single specimen examined the chitinous loop enclosing the vulva was rather narrower, as in *C. annulioris*, and the spermathecae were not so heavily chitinised, more regularly oval, and longer, having a length of about 105μ, breadth about 80μ, and the chitinised portion of the ducts about 6μ. Small setae on the ventral aspect of the ventral process of the tenth segment (fig. 17 *g*) rather more numerous, about six or seven on each side.

C. quasigelidus, Theo. One specimen. As in *C. fatigans*, but in the single specimen examined the loop of chitin enclosing the vulva is more V-shaped, and the spermathecae are rather larger, the middle one measuring 103μ by 72μ, the lateral ones 91μ by 69μ, and the ducts being short, 4μ and 2μ respectively.

C. rima, Theo. One specimen. Closely resembling *C. insignis*. In the single specimen examined the cerci were small and curved dorsally, as in *C. insignis*, and the apices of the spermathecae were broad and not narrowed as they often are in *C. fatigans*. The eighth sternite also appeared to be more deeply notched than in *C. fatigans*, and the ventral process of the tenth segment (fig. 17 *i*) more hairy, bearing a row of about five small setae on each side on the ventral aspect.

C. thalassius, Theo. Seven specimens. Similar to *C. fatigans*, but loop of chitin enclosing the vulva rather narrower posteriorly, and spermathecae more regularly oval, and in some specimens a little larger (103μ by 68μ in one). Small setae on the ventral aspect of the ventral process of the tenth segment (fig. 17 *k*) rather more numerous, about five on each side.

C. tigripes, Grp., var. *fuscus*, Theo. Three specimens. Very highly chitinised. Generally similar to *C. fatigans*, but larger. Cerci about 180μ by 105μ. Spermathecae very highly chitinised, shaped as in *C. fatigans*, the middle one the larger, about 110μ by 85μ, the lateral ones about 97μ by 76μ; the chitinised portion of the ducts is about 8μ long. The tuft of setae on the lining membrane of the eighth sternite is rather larger than in *C. fatigans*. The ventral process of the tenth segment (fig. 17 *l*) is not notched, and is rather more conical and hairy than in *C. fatigans*, there being about six small setae on each side on the ventral aspect.

C. tritaeniorhynchus, Giles. Two specimens. Apparently indistinguishable from *C. fatigans*, but the spermathecae are, perhaps, a little more regularly oval, and the ventral process of the tenth segment (fig. 17 *m*) rather more hairy, having four or five small setae on each side on its ventral aspect.

The genitalia of the twelve species examined were so much alike that they could be distinguished, if at all, only by means of minute differences, which in some cases cannot be accepted as of specific value owing to the materials being insufficient to exclude the error

due to the natural range of variation. Judging solely from the specimens we have examined, however, points of distinction appeared to be present in the size of the cerci, the shape and size of the spermathecae, the shape of the chitinised hoop round the vulva, the shape of the ventral process of the tenth segment, and the number of small setae (not including the larger setae near the apex) on the ventral aspect of this process.

From all the other species examined *C. duttoni* is readily distinguished by the sub-spherical shape of the spermathecae and the relatively long chitinised portion of the ducts, and *C. consimilis* by the large size of its oval spermathecae and the relatively numerous small setae (about nine on each side) on the ventral aspect of the ventral process of the tenth segment. Two other species, *C. annulioris* and *C. decens*, may, perhaps, be separated by the fact that in them the ventral process of the tenth segment is notched; and *C. tigripes* may be recognised by its size. Other points that may be of systematic value, such as the small size of the cerci in *C. rima* and *C. insignis*, and the scantiness of the hairs on the ventral process of the tenth segment in *C. fatigans* and *C. quasigelidus*, can be confirmed only by further experience.

Genus *Culiciomyia*

C. nebulosa, Theo. Five specimens. Genitalia of the same type as in the genus *Culex*, and very similar to those of *C. fatigans*, from which they appeared to differ only in having shorter cerci (about 115μ by 72μ), and in the ventral process of the tenth segment being shallowly notched and slightly more hairy, having about five small setae on each side on the ventral aspect. The spermathecae are also rather larger and less highly chitinised; the average measurements of the middle one being, length 99μ, breadth 69μ (one specimen measuring 110μ by 72μ), and the lateral ones, length 85μ, breadth 63μ; the chitinised portions of the ducts measure about 7μ in length.

Genus *Eumelanomyia*

E. inconspicuosa, Theo. Three specimens. Genitalia of the same type as in the genus *Culex*. Posterior extremity of the abdomen blunt, cerci not prominent, seldom projecting beyond the

eighth sternite. Tuft on the lining membrane of the eighth sternite small, composed of eight not very strong setae. Ninth segment as in *C. fatigans*, but loop enclosing the vulva very feebly chitinised. Cerci small, broad, extremities directed inwards; length about 105 μ, greatest lateral breadth about 50 μ. Ventral process of the tenth segment not notched, bearing a few hairs, none of which are very strong. Spermathecae three, oval, rather feebly chitinised, the middle one slightly the largest; average length about 88 μ, breadth 65 μ, the chitinised portion of the ducts short, about 7 μ.

Genus *Micraedes*

M. inconspicuosus, Theo. One specimen. Genitalia of the *Culex* type. Posterior extremity of the abdomen blunt, cerci not prominent. Eighth segment not retracted within the seventh; sternite with a shallow notch posteriorly. Ninth segment reduced as usual. Ventrally there is a small U-shaped bar of chitin enclosing the vulva, and more posteriorly a second strip of chitin forming a transverse arch. From the lining of the posterior part of the eight sternite, in the middle line, there projects backwards a tuft-like group of eight (four pairs) stout setae. Cerci short and broad, with truncated extremities; length 76 μ, breadth 45 μ. Ventral process of the tenth segment projecting a little beyond the cerci, broad, very slightly notched, and bearing on each side a few rather feebly chitinised setae, two of which, one apical and one slightly dorsal, are rather large. Spermathecae three, relatively large, moderately well chitinised, oval, and sub-equal; length about 57 μ, breadth about 46 μ. The chitinised commencements of the ducts are conical and rather long, about 10 μ.

Genus *Mimomyia*

M. splendens, Theo. (fig. 18, A and B). Three specimens. Posterior extremity of the abdomen bluntly conical, cerci rather prominent. Eighth segment not withdrawn within the seventh. Ninth segment much as usual; no U-shaped loop of chitin enclosing the vulva. Cerci of the usual form, obliquely set, rather small, length about 115 μ, lateral breadth about 65 μ. Ventral process of the tenth segment reaching posteriorly as far as the cerci, broad, very

hairy, apically and ventrally, and deeply notched. Spermatheca single, highly chitinised, sub-spherical, and relatively very large, diameter about 105μ to 115μ; there are numerous pale spots at the base, and almost no part of the duct is chitinised.

M. mimomyiaformis, Newst. Two specimens. Similar to *M. splendens*, but in the specimens examined the cerci were very short and broad, length 95μ, lateral breadth 72μ, and the ventral process of the tenth segment projected posteriorly beyond the cerci and was only feebly notched (fig. 18 c).

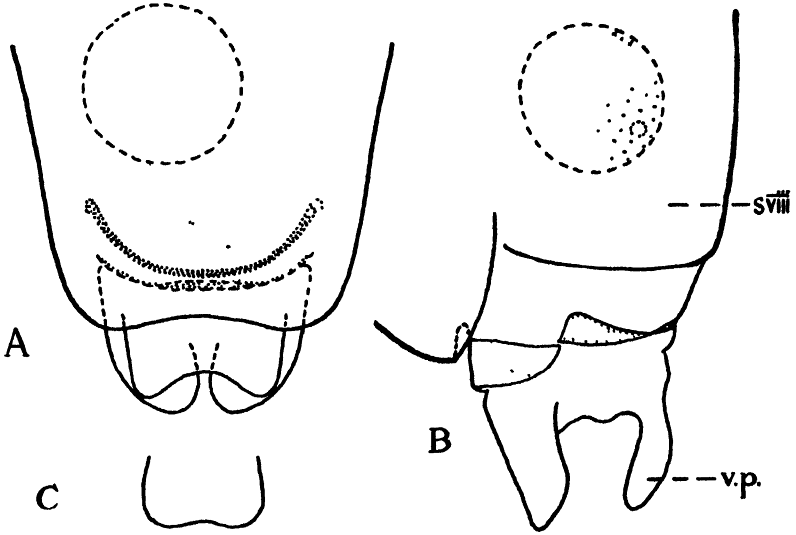

FIG. 18. *Mimomyia splendens*, Theo., posterior extremity of abdomen of female. *A*—ventral view; *B*—lateral view. × c. 185. *Mimomyia mimomyiaformis*, Newst.; *C*—ventral process of the tenth segment, ventral view. × c. 185.

M. plumosa, Theo. (fig. 19). One specimen. Genitalia unlike those of the two preceding species. Chitinisation of the ninth sternite rather strong, but there is no loop enclosing the vulva. Cerci obliquely set as usual, appearance varying greatly with the position: in a ventral view they are truncated, in a lateral view they are conc-shaped with a rather pointed extremity, and in sub-lateral view (the lateral aspect of the cerci) they are short and broad, about 150μ by 115μ, with their dorsal extremities prolonged into a

process. Ventral process of the tenth segment large, very hairy, deeply notched posteriorly (fig. 19 B). Spermathecae three, highly chitinised, sub-spherical to oval, the middle one the largest and measuring about 148 μ by 137 μ, the lateral ones smaller, about 122 μ by 106 μ; practically no part of the ducts is chitinised.

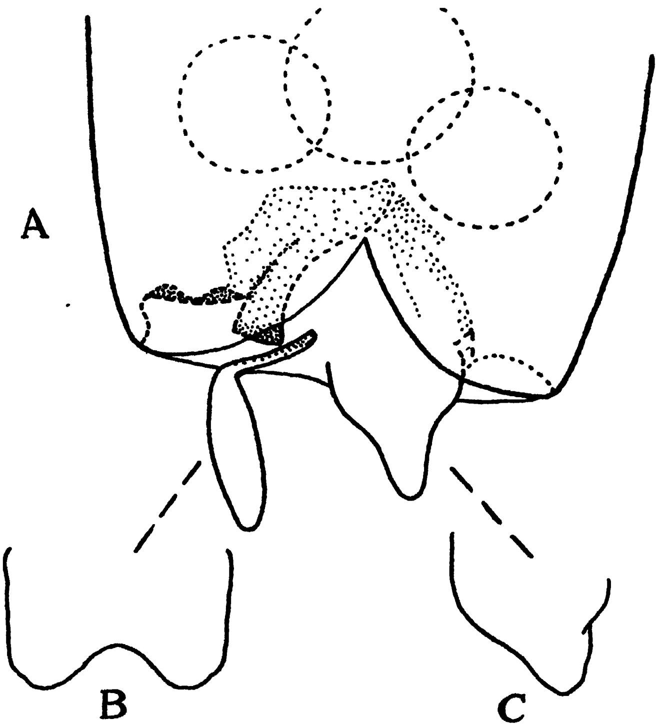

FIG. 19. *Mimomyia plumosa*, Theo. *A*—posterior extremity of abdomen of female, lateral view; *B*—ventral process of the tenth segment, ventral view; and *C*—one of the cerci, sub-lateral view. × c. 185.

Genus *Uranotaenia*

U. balfouri, Theo. One specimen. Very small, posterior extremity of the abdomen bluntly conical, the terminal segments not so far retracted as usual. Cerci (fig. 20 B) very short, broad; length

about 60μ, breadth about 45μ. Ventral process of the tenth segment about as long as the cerci, broad, without a notch and bearing a few but no very large setae. Spermatheca single, sub-

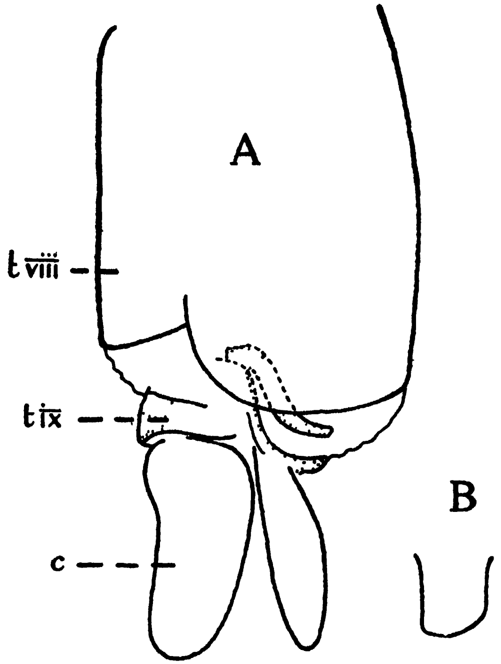

FIG. 20. *A—Uranotaenia annulata*, Theo., posterior extremity of abdomen of female, lateral view. × c. 185. *B—Uranotaenia balfouri*, Theo., one of the cerci, lateral view. × c. 185.

spherical, length abcut 91μ, breadth about 84μ; only the very commencement of the duct is chitinised.

U. annulata, Theo. (fig. 20 A). One specimen. Generally similar to *U balfouri*, but larger. Cerci rather long, with bluntish ends; length about 170μ, breadth about 68μ. Ventral process of the tenth segment nearly as long as the cerci, without a notch, bearing numerous setae, those at the apex being large. Spermatheca single, sub-spherical, length 80μ, breadth 76μ; practically no part of the duct (which is long and narrow) is chitinised.

Tribe *SABETHINI*

Genus *Eretmopodites*

E. chrysogaster, Grah. (figs. 21 and 22). Six specimens. Very highly chitinised. Posterior extremity of the abdomen blunt, cerci

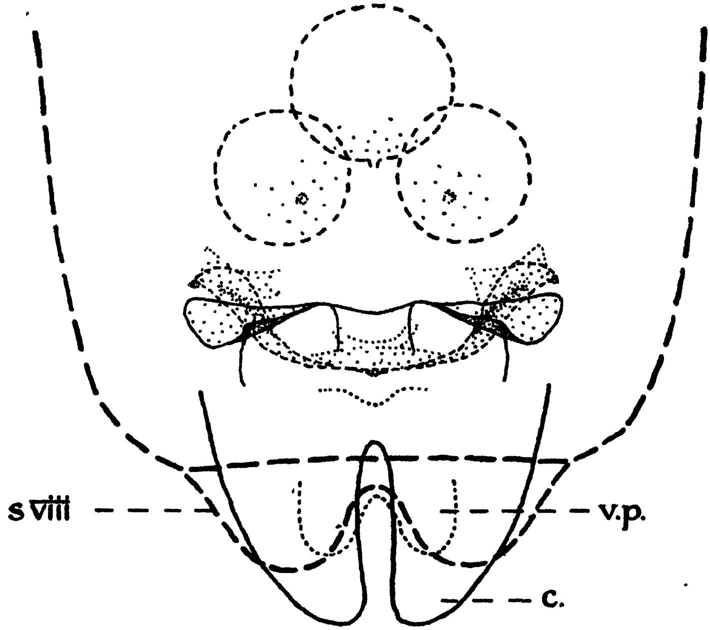

FIG. 21. *Eretmopodites chrysogaster*, Grah., posterior extremity of abdomen of female, dorsal view. × c. 185;

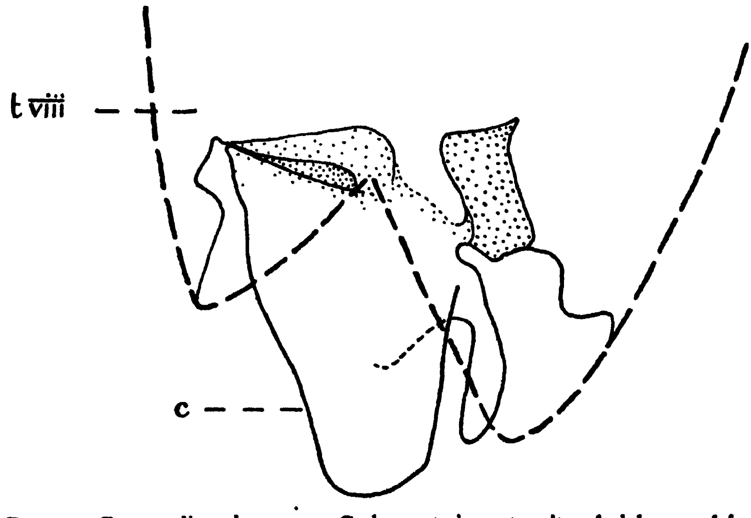

FIG. 22. *Eretmopodites chrysogaster*, Grah., posterior extremity of abdomen of female, lateral view. × c. 185.

projecting slightly. Eighth segment not withdrawn within the seventh, sternite projecting slightly further back than the tergite and with its posterior margin deeply notched in the middle. Ninth segment as usual much reduced, chitinised plates rather strong, arranged as shown in the figure. Cerci with blunt or truncated ends; average length about 200μ, breadth about 100μ. Ventral process of the tenth segment shorter than the cerci, deeply notched, bearing on each side numerous setae, one pair very strong. Spermathecae three, highly chitinised, sub-spherical; the middle one is the largest and has a diameter of about 110μ or more, the lateral ones are a little smaller, and are usually, but not always sub-equal, and have a diameter which in the specimens examined ranged from 91μ to 114μ, average 97μ The commencement of the ducts is chitinised for only a short distance, about 6μ; and there are a few pale spots round it at the base of the spermathecae.

E. quinquevittatus, Theo. (fig. 23). One specimen. Apparently

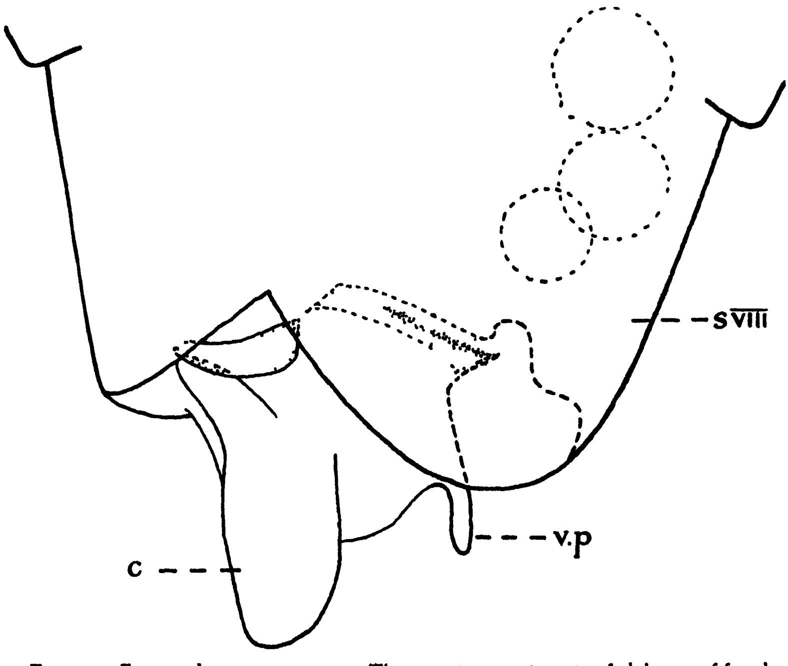

FIG. 23. *Eretmopodites quinquevittatus*, Theo, posterior extremity of abdomen of female, lateral view. × c. 185.

almost indistinguishable from *E. chrysogaster*; but in the specimen examined the cerci were slightly smaller, about 170μ by 87μ, and so were the spermathecae, the diameters of which were about 72μ, 91μ, and 68μ respectively, and no part of the ducts appeared to be chitinised.

NOTES ON AUSTRALIAN CESTODES

BY

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AND

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V. THREE CESTODES FROM THE BLACK SWAN

The three following species of Cestodes were found in the intestine of *Chenopsis atrata*, Lath. (the Black Swan), several of which were examined at Townsville, North Queensland:—

(1) *Nematoparataenia paradoxa*, n. g., n. sp.
(2) *Echinorhynchotaenia nana*, n. sp.
(3) *Hymenolepis lanceolata* (Bloch, 1782), Weinland, 1858.

(1) *Nematoparataenia paradoxa*, n. g., n. sp.

On a single occasion about twenty specimens of this worm were obtained.

EXTERNAL ANATOMY.

The worm measures about 9 mm. in length and 4 mm. in breadth except at the posterior extremity, where it expands into an oval saccular portion measuring about 0·8 mm. in length by 0·6 mm. in breadth.

The cuticle exhibits no trace of segmentation, even under high magnification. In cross-section the worm is circular with a ventral indentation (figs. 3 and 4).

Head. The head is armed with four suckers measuring 80μ to 100μ in diameter. They are borne on short pedicles about 100μ long, which are situated about 200μ from the anterior extremity. The anterior end of the head is occupied by a wide cup-shaped cavity about 400μ deep, bearing round its margin twelve flattened tentacular processes with minute spines about 2μ long closely arranged around their borders. These tentacles are similar to those seen in the various species of the genus *Parataenia*, Linton; they

measure about 120μ long and 40μ broad. There is a well marked neck about 500μ in length, which narrows to about 300μ in

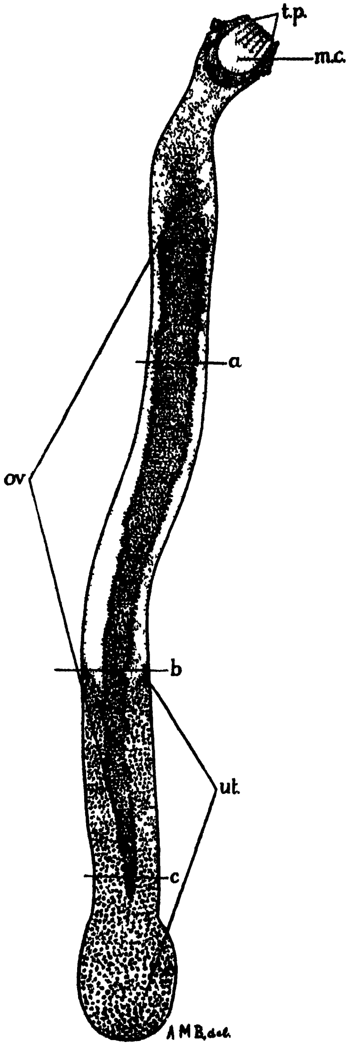

FIG. 1. *Nematoparataenia paradoxa*, n.g., n.sp. Complete worm. *a*—position of fig. 2; *b*—position of fig. 3; *c*—position of fig. 4; *m.c*—mouth cavity; *ov*—ovary; *t.p*—tentacular processes; *ut*—uterus. $\times$ 17.

diameter. The remainder of the worm is cylindrical with a longitudinal groove running along its ventral surface (fig. 1).

INTERNAL ANATOMY.

Muscular system. This consists of a series of separate longitudinal fibres arranged in an irregular double row immediately beneath the cuticle. No transverse or dorso-ventral fibres were seen (figs. 2 and 3).

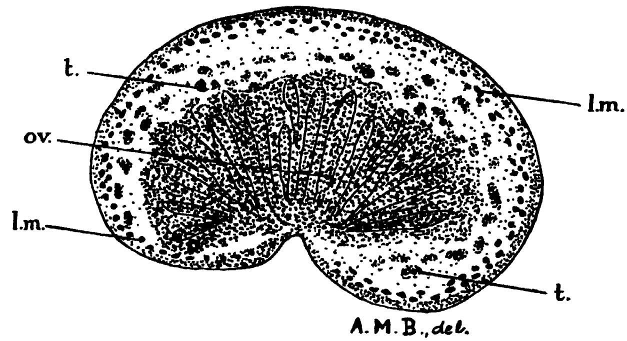

FIG. 2. *Nematoparataenia paradoxa* n.g., n.sp. Transverse section at *a*—fig. 1; *l.m.*—longitudinal muscle fibres; *ov*—ovary; *t*—testes. × 140.

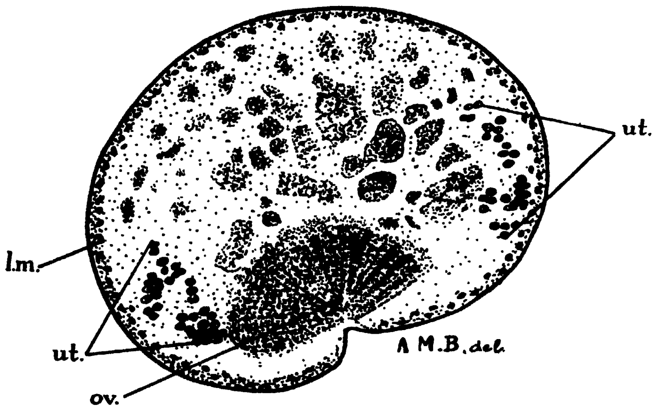

FIG. 3. *Nematoparataenia paradoxa* n.g., n.sp. Transverse section at *b*—fig. 1; *l.m.*—longitudinal muscle; *ov*—ovary; *ut*—uterus. × 140.

Nervous and excretory systems. No details of these could be made out.

Genitalia.

Testes. The testes are small and extremely numerous, they lie in the dorsal and lateral fields (fig. 2); towards the middle of the worm they begin to become fewer in number.

Vas deferens. No vas deferens, cirrus, or genital pore was seen.

Ovary. The ovary is situated ventrally and occupies the middle threequarters of the worm's length. In whole mounts the ovary shows no trace of segmentation, except that the lateral margins are serrated (fig. 1); in cross-section it is fan-shaped, the lobes radiating dorsally and laterally from a central point opposite the ventral groove; towards the posterior it gradually atrophies.

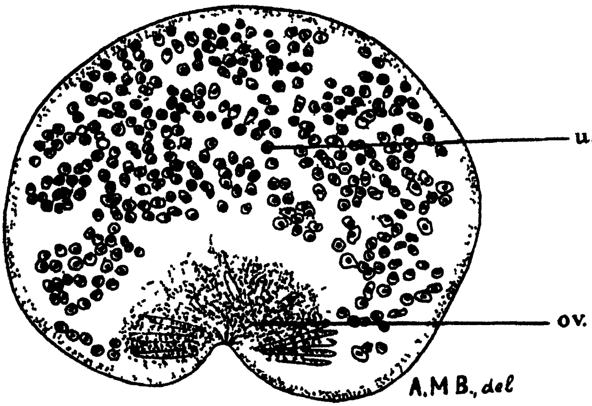

FIG. 4. *Nematoparataenia paradoxa* n.g., n.sp. Transverse section at *c*—fig. 1; *ov*—ovary; *ut*—uterus. × 140.

Vagina and receptaculum. These structures were not seen.

Uterus. The uterus begins about the junction of the middle and posterior thirds of the worm. It first appears at each side close under the cuticle, and as the ovary atrophies the two lateral limbs of the uterus gradually increase in size until they unite, and finally it occupies the whole of the body.

Eggs. The eggs are circular and measure about 10μ in diameter; further details could not be determined.

DIAGNOSIS.

This worm resembles *Parataenia medusia*, Linton (1890), only in its possession of tentacular processes on the head. It also bears a superficial resemblance to *Nematotaenia dispar*, Lühe (1899) in being unsegmented. Apart from these slight resemblances to the

above two species, this worm has characters entirely different from any known worm; this necessitates its being placed in a new genus, which we have named *Nematoparataenia*, and of which the following is the definition:—

Nematoparataenia, n.g.

Cylindrical worms with four suckers, and a number of digitate processes on the head. No trace of internal or external segmentation.* Type species *Nematoparataenia paradoxa*.

The type species is in the Museum of the Liverpool School of Tropical Medicine.

(2) *Echinorhynchotaenia nana*, n. sp.

About twenty specimens of this worm were obtained. Unfortunately the material was in very poor condition, so a full description is not possible.

EXTERNAL ANATOMY.

The largest worm measured about 2 cm. in length and including the cuticular expansions, which occur on the posterior borders of the segments, 1·7 mm. in breadth; the breadth of the worm without these expansions is about 1·3 mm.

Head. The head is about 1·5 mm. broad and 2·3 mm. long. Viewed anteriorly it is square, with rounded corners; each corner is occupied by a very strongly developed sucker looking almost directly forwards, and with a diameter of about 450μ. In the centre of the anterior surface there is a small pit. When viewed from the side, the anterior surface is bluntly rounded, and the central pit, which is almost 300μ deep, is seen to lie anterior to the suckers. Behind each sucker is a lappet, as in *Anoplocephala perfoliata* (Goeze, 1782), Blanchard, 1848. Behind the lappets the the head narrows gradually to a width of about 600μ, at which point it is sharply marked off from the narrower anterior segments, which it tends to overlap, by a cuticular collar-like ring. There is no neck (fig. 5).

* Although we were unable to see definite signs of segmentation, it should be noted that all our specimens were fully gravid and, therefore, old, and it is quite possible that in younger worms there would be segmentation in the internal organs.

Segments. The segments are broader than long, the most fully developed being 2 mm. broad and 200μ long. They are like a number of saucers placed one within the other with the concavity facing posteriorly. This appearance is caused by the whole circumference of the posterior borders of the segments being provided with cuticular expansions about three times as long as the segments themselves. In cross-section the segments of the anterior two-thirds of the worm are nearly circular, whilst those of the posterior third are oval. The genital pores are unilateral and open on the right side.

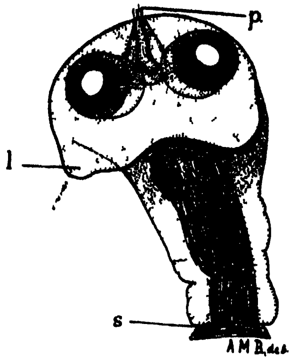

FIG. 5. *Echinorhynchotaenia nana*, n.sp. Scolex. *l*—lappet; *p*—fragment of proboscis; *s*—beginning of strobila. × 17.

INTERNAL ANATOMY.

Muscular system. The longitudinal muscle is disposed in two layers, an outer feebly developed layer consisting of a few small bundles, and a relatively enormously developed inner layer measuring 300μ in thickness (fig. 6). External to these are a few transverse fibres. No dorso-ventral fibres were seen. Four strands from the internal longitudinal layer run one to each sucker; the latter organs are extremely muscular, and in some specimens had actually fallen out of the scolex and appeared as almost spherical solid bodies.

Nervous system. There is a single lateral nerve on each side of the body lying external to the excretory vessels.

Excretory system. A number of excretory tubes can be seen in the head, and these unite to form two lateral vessels on each side. The two lateral vessels are of about the same diameter, and one lies directly dorsal of the other.

Genitalia.

Testes. The testes are three in number and they lie behind the ovary in the same transverse plane, two being on the aporal side. In full development they measure about 60μ in diameter.

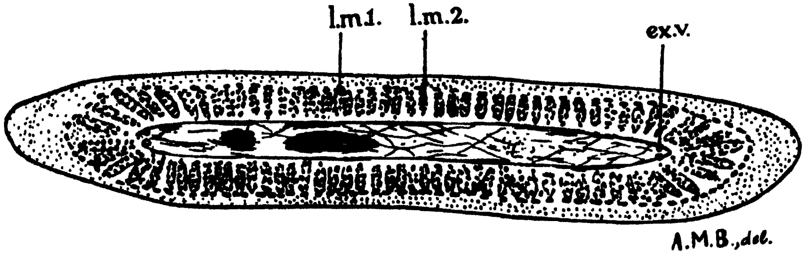

FIG. 6. *Echinorhynchotaenia nana*, n.sp. Transverse section towards posterior part of worm. *ex.v.*—excretory vessels; *l.m.*1.—outer longitudinal muscle layer; *l.m.*2.—inner longitudinal muscle layer. × 70.

Vas deferens. The vas deferens expands into a fairly large vesicula seminalis lying anterior to the mesial end of the cirrus pouch and connecting with the latter organ by a narrow duct. The cirrus pouch is 500μ long and 80μ broad, extending almost half-way across the segment. The cirrus is as long as its pouch and ends in a club-shaped extremity, the extreme end of which is surrounded by a small sphincter muscle. The external surface of the cirrus is closely

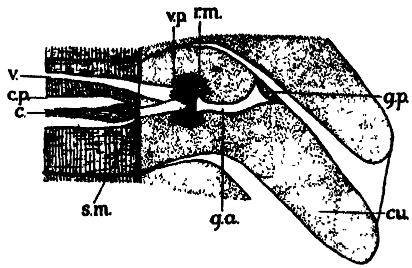

FIG. 7. *Echinorhynchotaenia nana*, n.sp. Termination of sex ducts. *c*—cirrus; *c.p.*—cirrus pouch; *cu*—cuticle; *g.a.*—genital atrium; *g.p.*—genital pore; *r.m.*—retractor muscle; *s.m.*—sphincter muscle at tip of cirrus; *v.*—vagina; *v.p.*—vaginal plug. × 40.

covered with minute spines. From the lateral border of the segment the male duct extends into the cuticle as a thin-walled tube, and it ends at its junction with the vagina which occurs about the centre of the cuticular expansion. From this junction the genital atrium runs laterally to open on the anterior surface of the cuticular prolongation about the junction of its inner and middle thirds (fig. 7).

Ovary. The material was in such a bad state of preservation that details relating to the ovary and vitelline glands could not be made out. The ovary is centrally situated in front of the testes, and all that could be seen was a number of acini, each measuring about 30μ in diameter.

Vagina and receptaculum. The vagina opens into the genital atrium immediately ventral to the male pore, and lying in its open end is a solid conical plug with a broad base (fig. 3). This plug is inserted into the slightly funnel-shaped opening of the vagina, and around the opening is a strongly developed muscle, which from the radial arrangement of its fibres probably acts as a retractor, drawing the walls of the vagina away from the plug. From the pore the vagina passes inwards anterior to the cirrus pouch, narrowing slowly until just internal to the excretory vessels it expands into a club-shaped receptaculum seminis, which runs as far as the median plane.

Uterus. The uterus is a simple transverse sac loosely packed with eggs.

Eggs. The eggs are circular and measure 40μ in diameter, and the oncosphere measures 32μ.

DIAGNOSIS.

Führmann (1909) erected the genus *Echinorhynchotaenia* to accommodate a species which possessed a proboscis-like rostellum armed with spines. Our worm closely resembles Führmann's species in its general anatomy except that the characteristic proboscis had been apparently torn out in all our specimens, but the appearance of the head, with a few ragged fibres protruding from the central pit, leaves no room for doubt that a proboscis has been present. The points in which our species differs from Führmann's *E. tritesticulata* are the following:—

	E. tritesticulata	*E. nana*, n.sp.
Length	30 cm.	2 cm.
Breadth	4–5 mm.	1·7 mm.
Lappets	absent	present
Apparatus at vaginal pore	absent	present
Genital atrium	absent	present
Position of genital pore	On anterior of lateral border of segment.	On anterior surface of cuticular expansion

We, therefore, consider ours a new species, and name it *Echinorhynchotaenia nana*.

The type specimen is in the Museum of the Liverpool School of Tropical Medicine.

(3) *Hymenolepis lanceolata* (Bloch, 1782), Weinland, 1858.

This cestode was found on four occasions. Many hundreds of specimens were obtained, and as they showed a wide variation in size and development, it is proposed to discuss these variations, since apparently they have not been noted in previous descriptions of the species.

The largest specimen was 55 mm. in length with a maximum breadth of 5 mm., and from these dimensions there were worms of every gradation in size down to specimens only 11 mm. in length by 0·3 mm. in breadth; that this difference in size is not altogether due to different ages of the specimens is shown by the fact that many of the smallest worms had a fully gravid uterus in their posterior segments.

Some of the smaller worms have only a part of the genitalia present. That is, either the male or female organs may be completely absent, but in no case was a worm seen in which both sets of glands were absent. In some without testes the uterus contains eggs; probably this is brought about by cross-copulation between different individuals. It may be held that the testes were originally present and have atrophied, but this is unlikely, as in the larger normal worms testes and ovaries are present together in all of the mature segments. In these small varieties the muscular system is poorly developed, with the result that the worms are very thin and diaphanous when compared with the larger ones. Another abnormality which was frequently observed was that the segments immediately behind the scolex rapidly increased in breadth in the normal manner, but after about the twentieth segment, instead of continuing to increase they became successively narrower for about a similar number of segments, after which the usual gradual and continuous increase took place.

At first glance it would appear that worms of different species were included under the one head, but that this is not the case is shown by the following points:—

(1) The scolex and the few segments immediately following it are the same in all cases.

(2) The cirrus, when present, is always of the same relative length and shape, no matter what the size of the worm.

(3) The male and female genitalia occupy the same relative positions in the segments, whether present complete or only in part.

(4) When a long series of material is examined, a regular sequence from the largest to the smallest worms can be obtained.

As normally developed worms departed in no particular from previous descriptions of the species *H. lanceolata*, detailed anatomy has not been given.

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THE INCIDENCE OF A DISEASE IN POPULATION GROUPS, THE NUMBER OF PEOPLE IN WHICH IS KNOWN OR UNKNOWN

BY

J. W. W. STEPHENS

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As an example of the 'incidence,' 'occurrence,' or 'distribution' of cases of a disease in one or more groups, such as age-groups of a population, the number of people in which is *unknown*, we may take the following. Of a total of twenty cases of influenza, let us suppose that ten occurred in Group A and ten in Group B, then the respective incidences ten and ten are equal, and the number that occur in each group per one hundred cases, viz., fifty and fifty, are also equal.

As an example of the 'incidence,' 'occurrence' or 'distribution' in age-groups, the number of people in which is *known*, we may take the following. Of a total of twenty cases of influenza, let us suppose that ten occurred in Group A, containing one hundred people, and ten in Group B, containing fifty people, then the incidences are 10 per cent. and 20 per cent. respectively (and the ratios of the incidences per one hundred cases 33 per cent. and 66 per cent. respectively).

It will be evident that the term 'incidence' has been used here in two different senses. In the first sense of the term, 'incidence,' it is only the number of cases that is known. In the second sense, when not only the number of cases but also the number of people among whom the cases occur is known, the term is applied to a figure expressing the number of cases that occur per one hundred people in each group.

To emphasise the distinction in meaning between these two uses of the term 'incidence,' it would seem advisable to confine the term 'incidence' to the use of the term in the first sense, and the term 'incidence rate' to the use of the term in the second sense.

In practice, however, certain deductions are often made when the number of cases alone is known, which can, as we shall see, be only justifiably made when the number of people in the groups is also known, *i.e.*, when the '*incidence rate*' can be calculated.

In regard to 'incidence,' the larger the group, the larger (*ceteris paribus*) is the incidence. In regard to 'incidence rates,' the factor of unequal size of the groups, if it exists, is eliminated, as the rate is calculated for one hundred people in each group.

The above examples may be tabulated as follows, using the words incidence and incidence rates in the sense defined above.

TABLE I.

Shewing distinction between incidence and incidence rate.

		1	2	3	4	5	6	7
	Group	Total number of people that occur in each group (Census)	Number of people that occur in each group per 100 people (Census)	Incidence, *i.e.*, total number of cases observed that occur in each group	Number of cases that occur in each group per 100 cases	Incidence rate, *i.e.*, number of cases occurring among 100 people in each group	Ratios of the incidence rates to one another	Ratios of the incidence rates to one another per cent.
Ex. 1.	A		...	10	50			..
	B			10	50			
Ex. 2.	A	100	66·6	10	50	10	1	33·3
	B	50	33·3	10	50	20	2	66·6

From the second example in the table we see that the 'liability to attack' of a person in Group A is 10 per cent. and in Group B 20 per cent., *i.e.*, it is twice as great in Group B as in Group A. This fact cannot, however, be deduced from the figures in the first example, because, although the number of cases is the same as in the second example, nothing is known as to the number of people among whom the cases occurred. It is the incidence rates (actual or relative) that are of importance if we are studying what may be termed the 'real incidence' of the disease on a group.

DIABETES

We find recorded in Osler and Macrea, *System of Medicine*, second edition, p. 675, the age-group incidence of three hundred and thirty-five cases of diabetes in Baltimore (column 3) from which can be readily calculated the age-group incidences per one hundred cases (column 4). The figures for the age-group, distribution or incidence of the population of Baltimore per one hundred people are not given, so that for purposes of illustration I have used those of Liverpool as deduced from the 1911 census (Table II, column 2).

TABLE II.

Showing incidences and ratios of incidence rates in Diabetes.

Age-Group	1 Total number of people that occur in each group (Census)	2 Number of people that occur in each group per 100 people (Census)	3 Incidence, *i.e.*, total number of cases observed that occur in each group	4 Number of cases that occur in each group per 100 cases	5 Incidence rate, *i.e.*, number of cases occurring among 100 people in each group	6 Ratios of the incidence rates to one another	7 Ratios of the incidence rates to one another per cent.
1–10 ...	...	23·3	8	2·18	...	0·0935	0·86
11–20 ..	...	18·9	25	7·34	...	0·3883	3·59
21–30 .	...	16·7	44	13·1	...	0·7245	6·71
31–40 ...	...	15·8	61	18·2	...	1·1519	10·67
41–50 ..	...	11·2	69	20·6	...	1·8392	17·04
51–60 ..	...	7·3	89	26·5	...	3·6301	33·64
61–70 .	...	4·5	33	9·8	...	2·1111	19·47
71–80 .	...	2·0	6	1·7	...	0·8500	7·87
81– .	...	0·3	0	0·0	...	0·0	0·0
	...	100·0	335	99·42	...	10·7886	99·85

If we were dealing with the total number of people in each group (column 1) instead of the number per one hundred of the population, and divided a figure in column 3 by the corresponding figure in column 1 and multiplied the result by one hundred, the figures obtained would represent the incidence rates, *i.e.*, the incidence per

one hundred people (column 5). But, in the present case, where we have divided the percentage figures in column 4 by the percentage figures in column 2, the resulting figures (column 6) represent simply the *ratios** which the incidence rates bear to one another, and from these we can easily calculate the ratios, when the sum of the ratios is one hundred (column 7). Thus, to refer to Table II (column 7), we see that of one hundred cases of diabetes about thirty-three would occur among so many people in the age-group 51-60, while about half that number (17·04) would occur among the *same number* of people in the age-group 41-50, whereas, considering the incidence merely (column 4), it is about the same in the two groups, viz., 20·6 and 26·5 respectively.

INFLUENZA

The following example (Table III) is taken from Nothnagel's *Encyclopædia of Practical Medicine*, English Edition. Article 'Influenza,' p. 571. The actual figures for the case incidence and the population incidence in the various groups are not given, but only the percentage incidences in each case, in the form of graphs. The figures are only approximately correct, as it was not possible to calculate them exactly from the graphs. As in Table II, by dividing the percentages in column 4 by the corresponding ones in column 2, we get a series of figures (column 6) which represent the ratios which the incidence rates bear to one another, and in column 7 the ratios of these rates per cent. Thus, the 'liability to attack' (column 7) in the age period 21-30 is slightly more than twice as great as in the age-period 51-60, but what the actual figures for liability to attack are it is impossible to say, as it is only the percentage and not the actual number of people in the groups that is known. The figures in column 7 are not comparable with those in column 4; strictly speaking, no conclusions as to 'liability to attack' can be based on the figures in column 4 by themselves. It is only if we assume *some* knowledge of the number of people in the groups that the case incidence figures have any value in this respect.

*The *ratios*, but of course not the same actual figures, in this column could equally well be got by dividing the figures in column 3 by those in column 2.

Thus, we could probably infer that the liability to attack was greater in the 21-30 period than in the 11-20 period, because we *assume* that the population of the 21-30 period is probably not twice that of the

TABLE III.

Showing incidences and ratios of incidence rates in Influenza.

Age-Group	1	2	3	4	5	6	7
	Total number of people that occur in each group (Census)	Number of people that occur in each group per 100 people (Census)	Incidence, *i.e.*, total number of cases observed that occur in each group	Number of cases that occur in each group per 100 cases	Incidence rate, *i.e.*, number of cases occurring among 100 people in each group	Ratios of the incidence rates to one another	Ratios of the incidence rates to one another per cent.
1–10 ...	...	19	...	8	...	0·421	5·86
11–20 ...	...	16	...	15	...	0·937	13·05
21–30 ...	...	21	...	32	...	1·523	21·07
31–40 ...	...	16	...	20	...	1·250	17·40
41–50 ...	...	12	...	14	...	1·166	16·23
51–60 ...	...	8	...	6	...	0·750	10·44
61–70 ...	...	5	...	4	...	0·800	11·14
71–80 ...	...	3	...	1	...	0·333	4·63
	...	100	...	100	...	7·180	99·82

11-20 period, but we can only make accurate deductions, giving relative or actual figures, when we base them on the number of people, relative or actual, in the groups.

BLACKWATER FEVER

It has been commonly stated that the liability to an attack of blackwater fever is greater in persons infected with malignant tertian parasites than in those infected with simple tertian or quartan parasites. These statements are based on the particular parasites present in so many *cases* of blackwater fever, but, as we have shown

above, no conclusions can be drawn as to liability to attack unless we have population data as well.

The case before us is parallel with the two examples we have already considered, though here, instead of age-groups, we have groups of persons (malaria cases) infected with the malignant tertian and simple tertian parasites respectively (Table IV). The data are

TABLE IV.

Showing relative liability to an attack of Blackwater fever of persons infected with malignant tertian and simple tertian parasites respectively.

	Parasite Group	1 Total number of case of Malaria that occur in each group	2 Number of cases of Malaria that occur in each group per 100 cases of Malaria	3 Total number of Blackwater cases observed that occur in each group	4 Number of cases of Blackwater that occur in each group per 100 cases of Blackwater	5 Incidence rate, i.e., number of cases of Blackwater that occur among 100 cases of Malaria in each group	6 Ratios of incidence rates to one another	7 Ratios of incidence rates per cent.
Ex. 1	Malignant tertian ...	...	74	...	76·4	...	1·032	53·2
	Simple tertian ...	...	26	...	23·6	..	0·908	46·8
		...	100	...	100	...	1·94	100·0
Ex. 2	Malignant tertian ...	...	68·45	...	54·03	...	0·789	35·1
	Simple tertian ...	...	31·56	...	45·96	...	1·456	64·9
		...	100·00	...	99·99	...	2·245	99·9

taken from a paper in the *Annals of Tropical Medicine and Parasitology*, Vol. VII, December, 1913, p. 487, in which I have summarised the data of Deeks and James, and Lovelace, respectively.

As before, the figures in column 6 are got by dividing those in column 4 by the corresponding ones in column 2. The figures in column 7 are then calculated for one hundred cases.

In the first example, the incidence rate of blackwater fever in malignant tertian infections is only slightly greater than that in simple tertian infections.

In the second example, the incidence rate in simple tertian infections is nearly twice as great as that in malignant tertian infections.

We are not concerned here with the discrepancy between the results, but with the fact that in each case deductions based solely on the incidence, *i.e.*, occurrence of malignant tertian or simple tertian parasites in the blackwater *cases*, would have led to different but erroneous conclusions.

A reference to the current text-books of Tropical Medicine would afford many other examples of a similar kind, where conclusions are drawn from a knowledge of the number of cases only, in the absence of any knowledge of the number of people among whom the cases occur.

THE EXPERIMENTAL INFESTATION OF *PHYSOPSIS AFRICANA*

BY

F. G. CAWSTON, M.D., Cantab.

First Streatfeild Research Scholar

(*Received for publication* 25 *May*, 1922)

Some notes on the experimental infestation of *Physopsis africana* in Natal may prove of use for reference to workers in other parts of the world who are engaged in the study of the life-history of the schistosomes.

It was some time before I succeeded in keeping this common fresh-water snail alive for any length of time under artificial conditions. The glass jars in which I observed the growth of young examples proved unsuitable for more than a few days; but wooden tubs, kept out of doors in a shady place, answered the purpose very well, and I was able to secure all I needed whilst the experiments were in progress. I did not find it necessary to change the water in the tubs, which contained a few water-plants and an increasing amount of decomposing leaves and small pieces of wood which fell in occasionally. The snails had, therefore, plenty of shade, whilst the water never became too hot, as it tends to do in a glass jar if placed in the sun. As 'millions' had been observed feeding on young snails, and as one did not wish to interfere in any way with the free ventilation of the water, nothing was done to prevent the breeding of mosquitoes. The surface area of the water was approximately double that of the bottom of the tubs.

It is possible that the rate of growth was handicapped by the food supply—and I have not succeeded in getting the common variety of water-lily to thrive in wooden tubs—but, even under what appear to be very favourable conditions, I do not find it possible to obtain examples large enough for experimental purposes under five months in Natal, and I should gather that by far the majority of

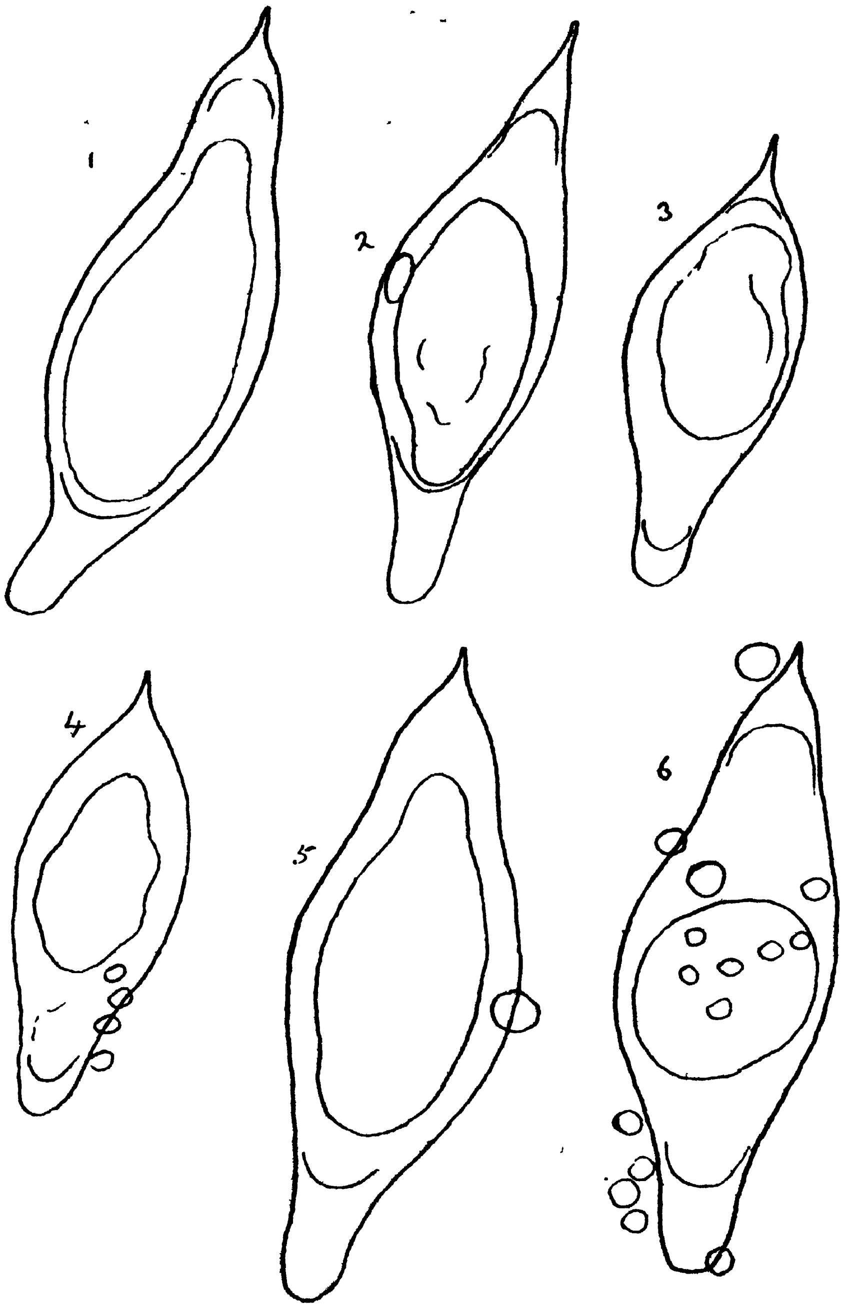

Fig. 1. Ova from urine of Natal boy. Note solid, long, rounded extremities. Average length 0·22 mm.; exceptional length 0.2625 mm.; abnormally bent end in 1. Living miracidia in 1, 2 and 5. Degenerative effects of emetine in 3, 4 and 6.

infested examples that I have found in the rivers and pools of South Africa were at least a year old. I have noted the presence of apparently mature cercariae in very small specimens from Natal rivers, and in some which were experimentally infested forty-six days before and the shells of which measured only 6·5 and 7·0 mm. in length; but it is rare to find such small specimens infested.

When required for the experiments, a number of well-developed examples, about 12 mm. in length, were selected and placed in a glass jar containing fresh water. The urine of a Bilharzia patient was then secured, and the ova collected by centrifugalising the specimen. The ova were examined microscopically, identified by

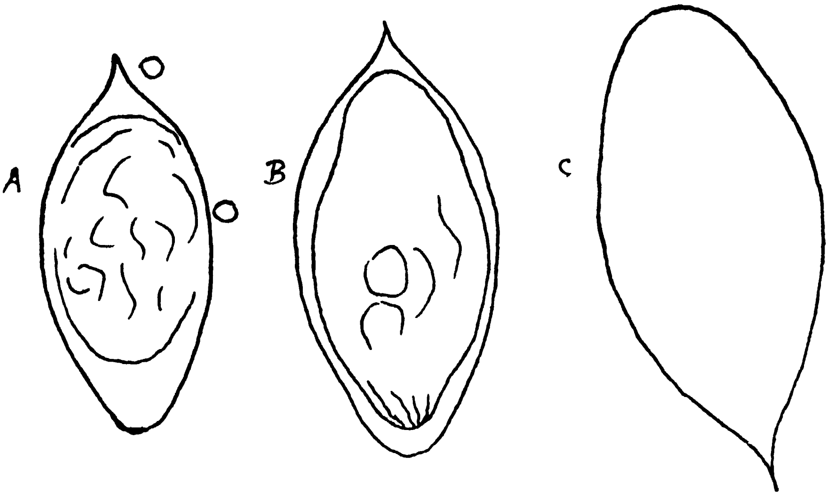

Fig 2. Ova of *S. haematobium* from same urine, showing (*B*) living miracidium about to hatch, and (*A*) miracidium degenerated under the influence of emetine.

means of their shape, size and spine as those of *Schistosoma haematobium*, and, as soon as the contained miracidia were seen to be ready to hatch, were emptied into the jar containing the snails and placed in a good light for a few hours. At the end of twenty-four hours the snails were then generally placed in a small wooden tub.

Some of the snails which had been thus exposed to infestation were placed in some dark glass jars containing a few decomposing leaves. The water in these jars were continually replaced by drops

from a glass tubing connected with a large tub containing water-weeds. Whilst the snails were thus continually receiving fresh water laden with food, the water was gradually escaping through a regulated syphon tube. This arrangement answered well for a few snails at a time.

Long spindle-shaped ova resembling those of *Schistosomum bovis* were found in the urine of two Natal-born Indian boys, associated with the typical ova of *Schistosoma haematobium*. Both varieties were added to water containing *Physopsis* which had been kept free from all other possible chances of infection by miracidia.

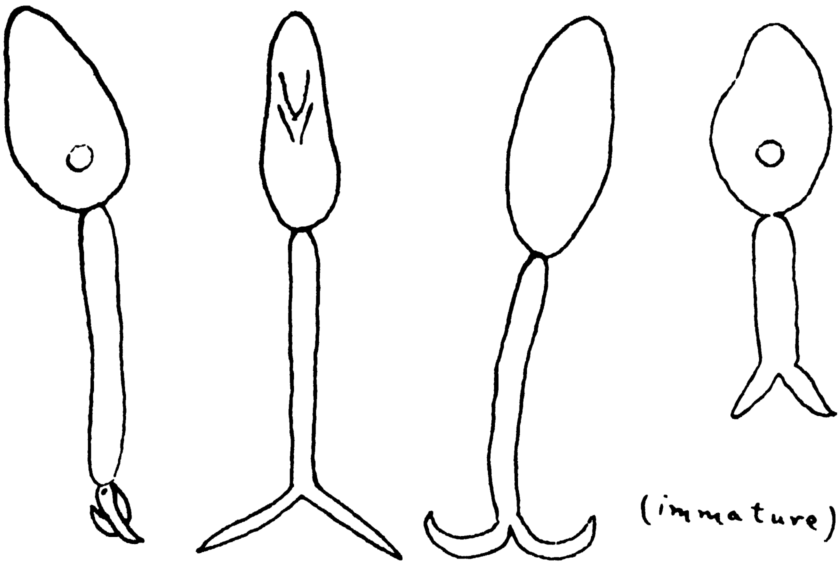

FIG. 3. Cercariae present in *Physopsis africana* 63 days after being exposed to the above ova. (×2.)

To imitate natural conditions, as far as possible, it is necessary to wait until cercariae are escaping into the surrounding water before using them for the experimental infection of animals. Although I have found apparently mature cercariae in *Physopsis* which has been exposed to miracidia only a fortnight before, I have never found the cercaria outside a snail until the development has been allowed to progress for thirty-five days, and it is probably better to keep the infested snails living for several months before dissecting them.

To ascertain whether the experimental infestation has been

successful in specimens one does not wish to destroy, it is best, as Dr. J. G. Becker once pointed out to me, to place individual snails in clean test-tubes in a good light, or even break off a minute portion of the shell over the liver. There may be certain conditions in the surrounding medium that encourage the mature cercariae to work their way out of the infested snail; but I have carefully examined specimens for several days, up to the sixty-fourth day, without any sign of free-swimming cercariae, when dissection revealed the presence of a number of mature cercariae within the liver substance.

Among about thirty individuals that I have found infested with schistosomes within one or two months after being exposed to the ova of *Schistosoma haematobium* and those resembling *S. bovis*, I have never seen any cercaria which shows eye-spots, development in rediae or possessing the long prongs that some of the schistosomes that I have found in *Physopsis* in the Natal rivers occasionally do. In every instance, when mature, the experimentally produced cercaria in *Physopsis* exposed to infection from the urine of a Bilharzia patient was 0·525 mm. in total length, possessed prongs which were about a quarter the length of the tail, and in other respects resembled the cercaria of *S. haematobium*.

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NOTES ON CULICIDAE IN VENEZUELA, WITH DESCRIPTIONS OF NEW SPECIES

PART II

BY

ALWEN M. EVANS

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PLATE XI

Since the completion of a previous paper (1921) we have received, through the kindness of Dr. Chacin and Dr. M. Núñez Tovar, a number of consignments of mosquitoes collected, during the Autumn of 1921, from the regions surrounding Caracas and Maracay.

Most of the species represented are common, and of wide distribution, but among them are a new species of the *Arribalzagia* group of *Anopheles* and a very distinctive new species of the *Janthinosoma* group of *Psorophora*.

Anopheles albimanus, Wied.

La Cabrero, Estado Carabobo, ♀ 1; Tapatapa, near Maracay, ♂ 1, ♀♀ 3; La Barraca, Maracay, ♀♀ 3. Dr. M. Núñez Tovar.

A. albimanus var. *tarsimaculata*, Goeldi.

San Francisco, near Maracay, ♀♀ 3; La Cabrero, Estado Carabobo, ♀♀ 4; La Barraca, near Maracay, ♀ 1; near Maracay, ♂♂ 2, ♀ 1. Dr. M. N. Tovar.

A number of specimens occurred in which the condition of the palpi was intermediate between the type *A. albimanus* and the variety *tarsimaculata*. Some specimens have the palpi with the penultimate joint with basal white ring; beyond, black scaled with a number of white scales scattered among the black ones about half-way between base and apex of segment. In other cases the penultimate joint with basal white ring and most of scales on outer side of a much paler brown than the rest of the dark palpal scales.

A. argyrotarsis, R.D.

San Francisco, near Maracay, ♀ 1. Dr. M. N. Tovar.

A. pseudopunctipennis, Theo.

San Francisco, near Maracay, ♂♂ 3, ♀♀ 2; La Cabrero, Estado Carabobo, ♀ 1; Tapatapa, near Maracay, ♂ 1, ♀♀ 3; La Barraca, near Maracay, ♀♀ 2. Dr. M. N. Tovar.

A. maculipes, Theo.

San Francisco, near Maracay, ♀ 1. Dr. M. N. Tovar.

Anopheles (*Arribalzagia*) *venezuelae*, sp.n. (Plate XI).

FEMALE.

Proboscis slightly more than 3 mm. Curved ventrally in distal half; labellae conical, dark ochraceous distally, shading to brown at base with a few fine dark hairs; vestiture of dark coppery brown scales roughened basally beneath. *Palpi* shorter than proboscis, clothed with black, spatulate scales sub-erect on basal third, yellow scales forming very narrow rings at apex, at base of last segment, and at middle of long segment; also a few scattered pale scales on distal half. Apex with a tuft of pale yellow hairs. Antennae with long segments densely clothed with fine decumbent hairs, setae of whorls sparse, pale. Third segment with a large patch of flat decumbent scales on upper and inner side on distal half, white proximally, ochraceous golden distally. Tori moderate, dark brown with white scales externally. *Clypeus* large, surface minutely punctate, olive brown proximally, ochraceous pollinose distally. Eyes deep black. Occiput with median grove; integument brown, light grey at margins of eyes and medially. Vestiture of dense upright forked scales, ochraceous in front, with a few whitish ones in middle, dark ones behind; posteriorly and laterally scales very dense, black. Space between eyes with pale narrow scales at borders, and many long creamy forwardly-projecting hairs. A few brown setae projecting forwards from posterior margins of eyes.

Prothoracic lobes with erect black scales and a few brownish hairs above; whitish scales below. *Mesonotum* greyish pruinose mottled with brown spots; three large black ocellar spots: two lateral and one posterior involving the scutellum. Vestiture of straw-coloured hairs, many of them arising from pigmented spots. Median area bordered by two

narrow longitudinal yellowish depressed bare stripes, and two wider bare depressions extending from the lateral ocellar spots to the posterior border of the mesonotum. At anterior border a group of strongly curled, pale yellow hairs. *Scutellum* greyish pruinose at sides, along posterior border a median and two lateral groups of yellow hairs and a continuous row of long dark setae. *Postnotum* nude, dark tawny ochraceous at sides with broad brown median stripe. *Pleurae* pale greyish pruinose with five large spots unicolorous with ocellar spots on thorax, dark brown basally. A few flat, white scales medially.

Abdomen dorsum uniform mouse grey, vestiture of fine yellow hairs. Distal margins of segments two to seven with a few black scales, and lateral projecting tufts of black spatulate scales with a few white ones near them. Eighth segment with pre-apical band of flat ochraceous scales, and border of flat black scales, and pale yellow hairs. Last segment black scaled. Venter greyish pruinose, with long yellowish hairs at sides of segments, and shorter dark hairs medially. Segments two to seven with broad, white semi-decumbent scales thinly scattered over surface; apical third with dense patches of sub-erect black scales. Venter of eighth segment with golden-yellow, appressed scales. Terminal segment black scaled.

Wings. First fork cell one and a half times as long as its petiole; second fork cell about as long as its petiole. *Basal cross vein very narrowly separated from anterior cross vein.* Three large black scaled patches bordered with white scales, with membrane beneath deeply infuscated, the largest median involving the costa, sub-costa and first and second veins; the smallest basal, involving the costa, sub-costa and first vein; the distal one involving the costa, first vein, and both branches of the second vein. Pale scales of wings mostly light yellow except white spots bordering large black patches. Costa mostly black scaled with ten small pale spots, four proximal to large median black patch; scales at apex of costa grey. Sub-costa mostly black scaled with small pale spots opposite those on costa, some decumbent pale scales on basal quarter, largely pale scaled beyond median black patch, apex pale. First vein, in addition to the three large black patches, with black decumbent scales on proximal eighth, between proximal and distal black patch, outstanding scales mostly pale, decumbent scales black; between median and distal black patches, vein mostly pale scaled, with one small black spot and a few scattered black scales. Beyond distal dark patch two grey spots;

apex of vein pale. Second vein: stem beyond median black patch mostly pale scaled, upper branch of fork black scaled on proximal half, beyond with pale scales and a few grey ones; apex grey. Lower branch of fork with a large proximal and apical dark patch, and two smaller dark spots separated by a pale patch. Third vein dorsally mostly pale scaled, with four black spots, two near the base, one apical, and one sub-apical; one or two black decumbent scales on central, pale area. *Third vein from below appearing dark scaled.* Fourth vein mostly black scaled, stem with many pale decumbent scales between the black ones. Proximally, rest of stem with seven pale spots, one at base of fork; branches of fork each with three pale spots; on upper branch the middle white spot elongate. Fifth vein mostly pale scaled, stem with three black spots at base, and many decumbent black scales on distal half. Upper branch of fork with four small and one large black spot, apex black; lower branch with two black spots distally, apex pale, both branches with a few black scales scattered among the pale ones. Sixth vein with seven black spots; apex black. Fringe with twelve pale spots, largest at apex of lower branch of fifth vein. Outstanding scales varying greatly in size and shape; on distal portions of veins lanceolate to narrowly ovate; on basal portions ovate with many very broadly ovate ones on fourth vein and sub-costa, some of those on sub-costa obliquely truncate. (Plate XI, fig. 1).

Halteres above densely white scaled with sub-circular dark median area; beneath densely black scaled, stem nude, ochraceous.

Legs. Very long and slender. Vestiture black with many white spots and bands. Femora and tibiae densely mottled with white spots. Hind tarsi with ten white rings or spots on first joint, seven on second, four on third; fourth and fifth white ringed at base and apex and in middle (Plate XI, fig. 2). Front tarsi with eleven white rings or spots on first joint, five on second, four on third and two on fourth and fifth. Third tarsi with ten white spots on first joint, five on second, four on third, three on fourth; fifth white with two narrow black rings.

Length 6·5 mm. Wing 5·5 mm.

One ♀ taken at La Cabrera, Estado Carabobo, Autumn, 1921, by Dr. M. Nunez Tovar.

This large and beautiful species approaches closely in the markings of the wing to *Anopheles* (*Arribalzagia*) *punctimacula*, Dyar and Knab, as described by Howard, Dyar and Knab (1917), under the name *A. malefactor.* The chief differences are tabulated below.

	A. punctimacula, D. and K.	*A. venezuelae*, sp.n.
Length	About 5·0 mm.	6·5 mm.
Wing	About 4·5 mm.	5·5 mm.
Vein III	'Two small spots *at* and near base and two others at and near apex, *a few black scales scattered along its whole length.*'	Base pale, two small black spots near base, two others at and near apex, only one group of two small black scales on rest of upper surface of vein.
Distance between anterior and basal cross veins	About equal to length of basal cross vein	Less than a quarter of the length of the basal cross vein
Hind tarsal segments 3	1 apical, 1 basal, and 1 median, white ring	2 white rings between white apical and basal rings
Hind tarsal segments 4	As third segment	With 1 apical, 1 basal, and 1 median ring
Hind tarsal segments 5	Entirely white (or with a black band)*	With two black bands

* Dyar, 1918

Limatus durhamii, Theo.

La Barraca, near Maracay, ♀ 1.

Culex quinquefasciatus, Say.

Houses and buildings in and around Caracas, ♂♂ 275, ♀♀ 738. Dr. Chacin. About 100 ♂♂ were determined by the genitalia. Near Maracay, ♂♂ 8, ♀♀ 4. Dr. M. N. Tovar.

Culex declarator, D. and K.

Near Maracay, ♂ 1, ♀ 1. Dr. M. N. Tovar.

Culex corniger, Theo.

Caracas, ♂ 1, ♀ 1. Dr. Chacin.

Aëdomyia squamipennis, Theo.

Near Maracay, ♀♀ 2. Dr. M. N. Tovar.

Mansonia titillans, Walker.

Near Maracay, ♀♀ 2. Dr. M. N. Tovar.

Psorophora posticatus posticatus, (Wied.) Dyar.

Near Maracay, ♂♂ 2, ♀♀ 5. Dr. M. N. Tovar.

Psorophora posticatus sayi, D. and K.

Near Maracay, ♀ 1. Dr. M. N. Tovar.

Psorophora lutzii, Theo.

Near Maracay, ♀♀ 2. Dr. M. N. Tovar.

Psorophora saeva, D. and K.

Near Maracay, ♀♀ 2. Dr. M. N. Tovar.

The specimens differed from the description of *P. saeva* in the monograph of Howard, Dyar and Knab (1917), in having the scales of the proboscis sub-erect.

Psorophora ciliata (Fab.) R.D.

Near Maracay, ♀♀ 2. Dr. M. N. Tovar.

Psorophora (*Janthinosoma*) *tovari*, sp.n.

FEMALE.

Proboscis uniform; labellae small, conical; vestiture of dark scales with violet reflections. Palpi about one-fifth of the length of the proboscis, curved, with partially erected black scales with violet reflections, and a few rather long, coarse setae. Antennae: long segments very dark brown, with delicate white decumbent hairs, setae of whorls blackish brown. Tori ochraceous externally, dark brown internally, dark area with a row of pale flat scales and a number of dark setae. *Clypeus* large, very shining black above, ochraceous at sides above, the colours separated in a distinct line at sides below shading to dark brown. *Eyes* large. *Occiput* wide; integument dark shining blackish-brown above, tawny below. Vestiture of broad very much curved (much more strongly curved than the pale scales on the mesonotum of *P. posticatus*, Wied.) creamy white scales scattered over entire surface, intermixed with creamy upright forked scales on median third, and with broad curved yellowish scales and dark brown setae on lateral thirds; coarse dark setae anteriorly, and a tuft of ochraceous setae projecting between eyes. Posteriorly, upright forked scales black.

Prothoracic lobes with silvery, much curved scales, and numerous very coarse, black setae. *Mesonotum:* integument very dark brown, dull. Vestiture on centre of disc of narrow curved, brown scales with brassy reflections, these scales extending laterally behind almost to wing roots.

Sides of disc with broad much curved, creamy scales resembling those on occiput intermixed with a smaller number of bronzy, broad, curved scales. A median band, narrowed behind, of broad, much curved, creamy scales, on anterior sixth. Posteriorly mesonotum partially denuded, antescutellar space dotted with spindle-shaped ochraceous and creamy white scales intermixed. *Pleurae:* integument dark, shining, sepia; above with creamy scales as on sides of mesonotum; below with numerous broad, flat white scales. *Scutellum* with broad, flat, creamy and yellowish white scales. *Postnotum* nude, dark brown, shining.

Abdomen. First segment with a median broad patch of creamy white, flat scales, scattered pale ones at sides and numerous fine pale hairs; laterally a conspicuous patch of creamy scales not visible from above. Segments two to six with dark bronzy scales with brilliant metallic blue reflections, and conspicuous apical bands of creamy yellow scales, continuous at sides with pale scales of venter. Segments two and three with creamy band narrowed at sides, and produced backwards medially forming a wide triangle with apex approaching within a third of the base of the segment. On segment four, median backward extension of band broader, truncated. Segments five and six with band broadest in middle, gradually narrowed at sides. Segment seven mostly pale scaled above.

Venter entirely clothed with pale golden and silvery scales, but proximal half of second segment denuded.

Wings: Membrane deeply infuscated. First fork cell one and a half times the length of its petiole; second fork cell slightly longer than its petiole. Basal cross vein separated from anterior cross vein by nearly its own length. Outstanding scales sepia, ligulate. *Halteres:* knobs brown, stems ochraceous. Metatarsi of hind legs with no sub-erect scales. Front and mid-femora pale straw coloured with dorsal broad stripe and apical narrow ring of bronzy scales with metallic violet reflections. Hind femur with bronzy metallic scales. Tibiae and tarsi clothed with dark bronzy metallic scales, a stripe of scales with ochraceous reflections on under sides of front and middle tibiae, lines of scales with brassy reflections on under sides of the metatarsi and tarsi. Hind legs with segments three, four and five of tarsi missing.

Claws of first and second tarsi with teeth :—1·1—1·1.

Length *c.* 5 mm. Wing *c.* 4 mm.

Two ♀♀ taken in region of Maracay, Venezuela. Dr. M. Núñez Tovar, 1921.

Aëdes argenteus, Poiret.

Houses and buildings in and around Caracas, ♂♂ 28, ♀♀ 327. Dr. Chacin. Near Maracay, ♂♂ 18, ♀♀ 6. Dr. M. N. Tovar.

Aëdes trivittatus (Coq.), D. and K.

Near Maracay, ♀ 1. Dr. M. N. Tovar.

Aëdes (*Finlaya*) *oswaldi*, Lutz.

Near Maracay, ♀ 1. Dr. M. N. Tovar.

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While the present paper was in the press an extensive collection of *Arribalzagia* sp. from the Panama Canal Zone has been obtained. A preliminary examination of these specimens leads me to consider that the characters on which Dyar (1918) defines the species of *Arribalzagia* in his tables may be extremely variable. It seems probable that, although the type of *A. venezuelae* does not fall under any of the species in this table, and does not agree in detail with any of the descriptions of the existing species, it is in reality a variety of *A. punctimacula*, D. and K. A detailed examination of the material is being made, and a further note on the subject will be published shortly.

EXPLANATION OF PLATE XI

Anopheles (Arribalzagia) venezuelae, sp.n.

Fig. 1. Wing.

Fig. 2. Last three segments of hind tarsus.

Both figures drawn with camera lucida.

FIG. 1

FIG. 2

A M E del.

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EXPLANATION OF PLATE XI

Anopheles (*Arribalzagia*) *venezuelae*, sp.n.

Fig. 1. Wing.

Fig. 2. Last three segments of hind tarsus.

Both figures drawn with camera lucida.

FIG. 1

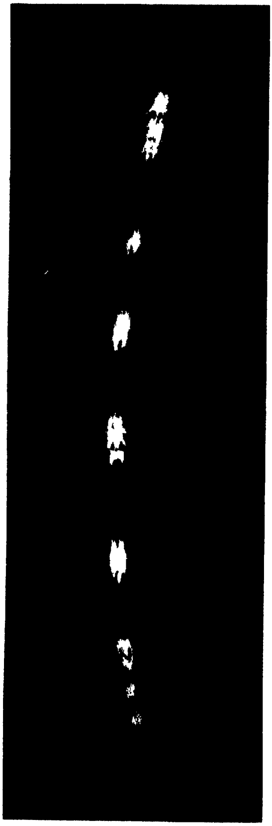

FIG. 2

A.M.E. del.

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ANCYLOSTOMES RECORDED FROM SIXTY-SEVEN POST-MORTEMS PERFORMED IN AMAZONAS

BY

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From the Research Laboratory of the Liverpool School of Tropical Medicine, Manáos, Brazil

(*Received for publication* 12 *June*, 1922)

This paper deals with the ancylostomes collected at sixty-seven autopsies, performed in the Santa Casa Hospital, Manáos, during 1921 and the beginning of 1922. With very few exceptions, all the subjects had resided for the greater part of their lives in the State of Amazonas, Brazil. They divided themselves into two natural classes:—(1) The 'Town-dwellers' and (2) the 'Country-dwellers,' the latter mostly agriculturalists, rubber-workers, etc., who either came into the town to be treated for sickness, or else who were taken ill when temporarily residing there.

METHOD OF COLLECTION. The gut having been opened, all ancylostomes, attached or lying loose in the lumen, were removed. The contents of the bowel were then distributed in large, flat, white dishes and examined for ancylostomes during three washings. All worms were washed in normal saline, killed with hot 75 per cent. alcohol, and stored in lacto-phenol (Leiper).

METHOD OF EXAMINATION. In the first part of the investigation an attempt was made to estimate the accuracy of a hand-lens (× 8) examination of the worms in order to determine sex and species. For this purpose, the worms obtained from fifteen post-mortems were examined as follows:—First with a hand-lens and a tentative diagnosis made as to sex and species (*i.e.*, whether *Necator americanus* or *A. duodenale*). They were then re-examined with a microscope, using the half-inch and the one-sixth.

The points of distinction noted, during the hand-lens examina-

tion, were (1) the general fineness, and (2) the sharply defined head curve, of *Necator americanus* as compared with *A. duodenale*. In this manner six hundred and sixty-two worms were examined; these consisted of eighty-five *A. duodenale* and five hundred and seventy-seven *Necator americanus*. The result was as follows:—One worm was diagnosed wrongly (*Necator americanus* male, mistaken for *A. duodenale* male); three other worms necessitated microscopical examination, but two of these proved to be so damaged that the head curve was destroyed; the remaining six hundred and fifty-eight worms were found to have been correctly diagnosed with the hand-lens.

With a view to testing whether *A. caninum* or *A. braziliense* could be distinguished from *A. duodenale* and *A. necator*, one male and one female *A. caninum* and one male *A. braziliense* (all from a cat) were mixed with sixty *Necator americanus* and eighteen *A. duodenale*. The worms were then separated into their species by the aid of a hand-lens, the result checked by a microscope and found to be correct.

The distinctions between *A. necator* and *A. caninum* or *A. braziliense* were based on the characteristic head curve of *A. necator*, between *A. duodenale* and *A. caninum* or *A. braziliense* on the smaller size and general fineness of the latter two species.

As this method appeared sufficiently accurate, the worms were sorted with a hand-lens in all subsequent examinations, any doubtful specimens, and these averaged one in sixty, being placed on one side and subsequently examined microscopically.

RESULTS. These are published in the form of a table for comparison with Darling and Smillie's (1921) figures for Brazil. Apparently their results are drawn from Southern Brazil, chiefly from Rio, Pernambuco, Sao Paulo, and a few from the State of Matto Grosso.

They state that 'the groups studied were all more or less similar in that they were composed largely of agriculturists. The average hookworm count of 136·1 per case, therefore, does not represent the degree of infection of *all Brazil*, but of *rural Brazil*.'

As my results are drawn from two classes, a second table is published showing a comparison between town and country infections. It must be noted that a few of the cases recorded had at one

time or another been in hospital, and a certain number of those had undoubtedly received Chenopodium.

On examining Table I, it will be seen that the most striking difference between the figures for Amazonas and South Brazil lies in the proportion of *Necator americanus* to *A. duodenale*, and, on examining Table II, that this difference is mainly due to the high average number of *A. duodenale* occurring in the country dwellers. Whereas Darling's rural dwellers for South Brazil show a proportion of *Necator americanus* to *A. duodenale* of 45 to 1, rural dwellers in Amazonas show a proportion of only 3·2 to 1.

Ancylostoma braziliense in human beings. Four worms belonging to the species *A. braziliense* were found among the six thousand eight hundred and fifty-seven ancylostomes, collected from the sixty-seven post-mortems. There were two males and two females; the males measured about 7 mm. in length and the females 7·5 mm.

Each worm was found in a separate host. Two were found in native Amazonians who, so far as is known, had never left the State of Amazonas; one in a patient who originally came from Ceara, and one in an American of the 'beach comber' type who had lived some twenty years in North Brazil.

I can find no previous record of *A. braziliense* being found as a human parasite in America. De Faria (1916) states that he examined children in Rio for this infection without success. Darling and Smillie (1921) do not record it among the sixty three thousand nine hundred and twenty-three hookworms they examined in South Brazil; but Darling (1920) writes:—'The ancylostomes encountered in man are *A. duodenale*, *A. ceylanicum*, *A. braziliense*, *Necator americanus*.' I cannot, however, find the authority on which *A. braziliense* is included.

According to de Faria (1910 and 1916) and Clayton Lane (1916), the distinction between *A. braziliense* and *A. ceylanicum* depends on the following two points:—

(1) *The inner ventral tooth.* This is smaller and finer in *A. braziliense* than in *A. ceylanicum*.

(2) *The bursa of the male.* De Faria (1916) states that in *A. braziliense* the rays, especially the dorso-external, are characterised by their great length, fineness and delicacy, whilst those of *A. ceylanicum* are shorter and thicker.

TABLE I

Comparing Ancylostome Infections for Amazonas and South Brazil.

	Amazonas July, 1921 to February, 1922	South Brazil (Darling) April, 1918 to January, 1920
Number of cases examined	67	469
Number of Ancylostomes found	6,857	63,923
Number of *Necator americanus*	5,660	62,554
Number of *A. duodenale*	1,193	1,369
Number of *A. braziliense*	4	—
Proportion of *Necator americanus* to *A. duodenale*	4·7 : 1	45 : 1
Average number of Ancylostomes to each individual	102·3	136·1
Average number of *Necator americanus* to each individual ...	84·4	133·2
Average number of *A. duodenale* to each individual	17·8	2·9

TABLE II.

Comparing Ancylostome Infection of Country and Town Dwellers in Amazonas.

	Country Dwellers	Town Dwellers
Number of cases examined	39	28
Number of Ancylostomes examined	4,144	2,713
Number of *Necator americanus*	3,157	2,503
Number of *A. duodenale*	985	208
Number of *A. braziliense*	2	2
Proportion of *Necator americanus* to *A. duodenale*	3·2 : 1	12 : 1
Average number of Ancylostomes to each individual	106·2	96·8
Average number of *Necator americanus* to each individual ...	80·9	89·3
Average number of *A. duodenale* to each individual	25·2	7·4

The distinction between the two was disputed by Leiper (1913). I have had the opportunity of comparing the following ancylostomes:—

(1) *A. brasiliense* from cats and dogs in N. Brazil.
(2) *A. brasiliense* from human subjects in N. Brazil.
(3) *A. ceylanicum* from cats and dogs in Bengal, India. (Material kindly supplied by Lt.-Col. Clayton Lane.)
(4) *A. ceylanicum* from West African dogs and South African cats.

As a result of careful examination of many specimens, I was unable to confirm the specific differences mentioned by de Faria and Clayton Lane.

No constant difference could be detected in the size and shape of the inner tooth of *A. braziliense* and *A. ceylanicum*, nor could any difference be discovered in the length and fineness of the dorso-external ray in the two worms (*vide* table).

TABLE III.

Comparing Measurements of the Dorso-external Ray in *A. ceylanicum* and *A. braziliense*

As named	Locality	Host	Number examined	Average length of worm	Average breadth D.E.R.	Average length D.E.R.	Ratio length D.E.R. to length worm	Ratio breadth D.E.R. to length worm
				mm.	μ	μ		
A. ceylanicum	Berhampore, Bengal	Cat ...	3	5·6	14	176	1 : 31	1 : 400
A. ceylanicum	Berhampore, Bengal	Dog ...	1	7·5	21	217	1 : 34	1 : 357
A. ceylanicum	Accra, West Africa	Dog ...	3	7·0	20	270	1 : 25	1 : 350
A. braziliense	Manáos, North Brazil	Dog ...	4	6·5	17	171	1 : 38	1 : 382
A. braziliense	Manáos, North Brazil	Cat ...	3	6·1	17	186	1 : 32	1 : 358
A. braziliense	Manáos, North Brazil	Human	2	7·0	14	162	1 : 43	1 : 500

SUMMARY

Six thousand eight hundred and fifty-seven ancylostomes collected from sixty-seven autopsies performed in Manáos, Amazonas, were examined, with the results recorded. A far higher proportion of *A. duodenale* to *Necator americanus* (1 : 4·7) occurred in Amazonas than recorded by Darling for South Brazil (1 : 45). This high proportion of *A. duodenale* was shown to be chiefly due to the country dwellers in Amazonas, whose *A. duodenale* to *Necator americanus* ratio was 1 : 3·2, while that of the city dweller was 1 : 12.

A. braziliense was found in four of the post-mortems.

The comparison of these worms and other two-toothed ancylostomes from dogs and cats in N. Brazil and India, and also from cats in South Africa and dogs in West Africa, failed to show the difference claimed to exist by de Faria between *A. ceylanicum* and *A. braziliense*.

My thanks are due to Dr. Thomas for much of the post-mortem material.

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THE SUSCEPTIBILITY OF THE INDIVIDUAL TO THE BITES OF *STEGOMYIA CALOPUS*

BY

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(Received for publication 27 May, 1922)

The usual belief amongst Europeans residing in the Tropics, with regard to the susceptibility of the individual to the biting of mosquitoes, would appear to be that the new-comer receives proportionately more bites than the old resident, but that the native of the country receives less than either.

Marchoux, Salimbeni and Simond (1903), writing of *Stegomyia calopus*, state ' . . . Il a une prédilection marquée pour la race blanche.' And later in the same article, ' Il s'attaque beaucoup plus avidement aux individus jeunes, vigoureux, qui ont la peau fine et le teint coloré, qu'aux individus anémiés ou âgés.'

It appeared of interest to test the truth of this idea and, at the same time, to investigate the following points with regard to their influence on the biting of mosquitoes: (1) Sweating; (2) hairiness of skin exposed to bites; (3) colouration; (4) age. Attention was also paid to the subsequent local reaction to the bites.

Nature of Experiment. All experiments were performed with *Stegomyia calopus*, owing to its being a day-feeder and the commonest mosquito in the locality.

Sixteen experiments were performed, at each of which a number of male persons, usually six, of various nationalities and different lengths of residence in Brazil, were exposed, under the same conditions, to the bites of a number (usually forty-five to fifty) of

hungry *Stegomyia calopus* females. The number of completed feeds performed on each individual during 30 minutes were noted.

Apparatus used and Method of Recording Results. The feeding-box consisted of a large mosquito cage measuring 24 by 15 by 12½ inches, and fitted with six sleeves. All experiments were performed in daylight at approximately the same hour, and the box placed in such a position that it was as far as possible evenly illuminated.

Mosquito cage used for the experiment. In practice, the sleeve was fitted closely to the forearm, at its junction with the cage wall.

Forty to fifty female mosquitoes, which had been kept unfed for at least four days since their date of emergence, were released in the cage. The individuals to be tested then introduced one of their hands through the sleeves so that each had the same amount of forearm and hand exposed to bites.

It was found in practice that the female *Stegomyia*, unless disturbed, never bit twice, and counts could be made easily and accurately.

After the first two experiments it was noted that mosquitoes that bit on the under surface of the wrist and hand were hard to count, and, at Dr. H. Wolferstan Thomas's suggestion, in all subsequent experiments, cardboard shields were used to protect this surface.

An example of an experiment is given to show the data recorded.

EXPERIMENT 3. Date: 3.10.21. Number: *Stegomyia calopus* = 50.

Name	Age	Colouration	Hairiness of exposed arm	Nationality	Number of years in Brazil	Residence in other countries with service in each	Sweating: first 15 mins.	Sweating: second 15 mins.	Number of bites received
O.K. ...	30	Dark	0	British	9	England only	+	+	8
M.L. ...	35	Dark	0	Portuguese	16	Portugal 20 years	+	+	13
B.E. ...	25	Fair	0	British	2	England and Canada only	0	+	7
M.S. ...	20	Dark	0	Brazilian	18	Nil	0	0	8
T.S. ...	47	Fair	+	Canadian	15	England and Canada only	0	+	3
L.O. ...	23	Dark	+	Brazilian	23	Nil	+	+	9

RESULTS.

I. Length of Residence.

	Total number of individuals tested	Total number of bites received	Average number of bites received by each individual
Persons above 5 years' but under 30 years' residence in Brazil. (Majority 10-15 years)	62	462	7·4
Persons under 2 years' residence in Brazil. (Majority under 1 year, some a few weeks)	26	157	6·0

II. Sweating.

	Total number of individuals tested	Total number of bites received	Average number of bites received by each individual
Persons sweating on the exposed forearm and hand ...	30	212	7·0
Persons not sweating on the exposed forearm and hand	58	407	7·0

III. Hairiness.

	Total number of individuals tested	Total number of bites received	Average number of bites received by each individual
Persons showing a considerable amount of 'hairiness' on the exposed forearm and hand	40	286	7·1
Persons not showing any marked 'hairiness' of exposed forearm and hand	48	333	6·9

IV. Colouration.

	Total number of individuals tested	Total number of bites received	Average number of bites received by each individual
Persons of a dark colouration ('dark' being used in the accepted sense of dark eyes and hair)	62	441	7·1
Persons of a fair colouration	26	178	6·8

V. Age.

	Total number of individuals tested	Total number of bites received	Average number of bites received by each individual
Persons of 30 years and under	29	194	6·6
Persons of more than 30, and less than 40	36	277	7·6
Persons of more than 40	23	148	6·4

VI. Nationality.

	Total number of individuals tested	Total number of bites received	Average number of bites received by each individual
Persons of British, Canadian or American extraction ...	57	352	6·1
Persons of Portuguese extraction	23	193	8·3
Persons of Brazilian extraction	6	59	9·8
Persons of Chinese extraction	1	7	7·0
Persons of African native extraction	1	8	8·0

Local Reaction. It was found impossible to record this in figures for lack of standard comparisons, but the impression of all observers during the experiment was that, as a class, the new-comers reacted most, the long-resident Europeans less and the native Brazilians least; in the case of the last named, as a rule, no reaction whatsoever could be detected.

SUMMARY

Before any conclusions can be drawn from these figures, two fallacies must be considered :—

(1) To obtain true results each of the sixteen experiments should be considered on its own merits, but this would demand too much space; as, however, it was arranged that as far as possible at each experiment approximately the same proportion of variable factors (*i.e.*, hairiness, nationality, etc.) should be present, and as the proportion of sweating to non-sweating individuals remained nearly constant, it appeared legitimate to add together the number of bites received in the sixteen experiments.

(2) The number of individuals tested and the number of bites recorded are so small that no definite conclusions can be drawn; they merely *suggest* what follows :—

Eighty-eight male persons of various nationalities and ages were tested with regard to their susceptibility to the bites of *Stegomyia calopus*. Six hundred and nineteen bites were received in all. The following factors were recorded :—

(1) Length of residence in Brazil; (2) sweating of surfaces exposed to bites; (3) hairiness of skin exposed to bites; (4) colouration; (5) age; (6) nationality.

The resulting figures would seem to show that none of these factors exert any marked influence on the number of bites received by the individual.

The theory that the number of mosquito bites received by the new-comer is greater than those received by the old resident, both being greater than those received by the native of the country, would appear to be, in part at any rate, attributable to the local reaction immunity displayed by the native, and to a less extent by the old resident.

I am indebted to Dr. H. W. Thomas for much help and suggestion.

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TUBERCULOSIS IN THE SUDAN, WITH NOTES ON A CASE OF BREAST TUBERCULOSIS IN A SUDANESE

BY

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(*Received for publication* 17 *June*, 1922)

PLATE XII

It would appear from the number of papers recently published dealing with the subject of 'Tuberculosis in the Tropics' that interest in this disease has been awakened, and in view of its importance, the writer feels little apology is needed for offering some general observations on 'Tuberculosis in the Sudan.'

Unfortunately, such observations can in no sense be considered complete, as they are based on a limited amount of clinical and pathological material obtained during the past fourteen years from almost every district of the Sudan. Limited though this material has been, it is in the main representative of a disease which, happily, has not assumed the proportions prevailing in Western countries or even in some of the towns of the Far East.

The reason for this is not far to seek. At the present time the Sudan lacks the thickly populated centres of other countries in the West and East. Vast tracts of desert waste and swamp still await to be linked up by means of railways, and although inter-tribal trade and communications have been encouraged under British administration, there still exists in certain parts a conservatism fostered by racial and religious differences, which will take years to break down.

Once these obstacles are removed, the seeds of tubercle will assuredly grow and be disseminated on what can only be considered a virgin soil.

Any opinion offered as to how and when the disease was first introduced into the Sudan can merely be hypothetical.

In the days of Mahdism and up to the time of the British occupation, the country certainly enjoyed a comparative seclusion from the tide of civilization. On the Northern frontier, little intercommunication occurred with Egypt. The perils attendant on the long desert wastes of this region acted as a deterrent to intimate relations between the two countries, and it is safe to infer that little encouragement was offered to the pagan tribes of the South and West, while on the Eastern Abyssinian frontier, the racial and religious differences of the two countries were sufficient reasons for keeping them aloof.

It is, however, to the earlier history of the country that one must turn for information regarding the introduction of tuberculosis; this history, as will be seen from archaeological records, is intimately connected with the ancient history of Egypt.

As far back as 2600 B.C. the Northern Sudan was invaded by the Egyptians, and from 2000-1000 B.C. this portion of the Sudan appears to have been occupied by them and regular colonies established as far south as Kerma in the Dongola Province.

That tuberculosis was existent among the Egyptians during these periods was established by the late Sir Armand Ruffer (1921), whose work on the 'Palaeopathology of Egypt' is well known. In an admirable collection of his studies on the subject, edited by Prof. Moodie, of Illinois University, there are plates illustrating Pott's disease in figures discovered in the tombs of Beni Hassan, 2000 B.C. Two other plates also depict graphically Pott's disease, and a large psoas abscess in a mummy of a priest of Ammon of the XXIst Dynasty, 1000 B.C.

Derry's (1907-08) investigations recorded in the 'Archaeological Survey of Nubia,' apart from representing the first record of tuberculosis in the Sudan, afford circumstantial proof of the introduction of the disease from Egypt into Lower Nubia, and it appears reasonable, therefore, to infer that tuberculosis obtained a footing in the Sudan synchronously with the tide of settlers from Egypt, but did not spread throughout the country for reasons already mentioned.

At the present time there is little doubt that the disease is practically confined to the larger towns of the Northern Sudan.

It is here that the factors concerned with stress, and resultant to a great extent on civilization, play no small part. Overcrowding,

intestinal parasitism, malaria, venereal disease, alcoholism and the 'hasheesh habit' undoubtedly predispose to infection by lowering the resistance of individuals peculiarly susceptible to the virus of tubercle.

Amongst the hardy, simple-living nomadic tribes of the desert and the comparatively secluded tribes of the South, the disease is practically unknown; with increasing facilities for inter-communication, however, such a state of things is unhappily not likely to continue.

For obvious reasons, more especially when one is dealing with a Mahommedan population, it is impossible to obtain statistics regarding the incidence of, or death rate from, tuberculosis. Racial and religious prejudices often interfere with the calling in of qualified medical aid, and post-mortems are rarely obtained except in cases presenting a medico-legal aspect. Consequently one is compelled to admit that figures obtained from hospitals and dispensaries do not represent the true incidence of tuberculosis in the country, and the writer is of the opinion that such incidence is higher than is suspected. Unfortunately von Pirquet's test has not been carried out on a sufficiently large scale to permit of any deductions being made.

The tribes of the Sudan are very susceptible to such respiratory diseases as bronchitis, broncho-pneumonia and pneumonia, and their predisposition to tuberculosis was referred to many years ago by Balfour (1904). The Sudanese or 'black' appears peculiarly susceptible, and it is stated that the Hadendowa, a black tribe inhabiting the hills of the Red Sea, shares this susceptibility. Other observers, notably Bushnell (1920) and Cummins (1920), have called attention to the susceptibility of coloured races to tuberculosis.

Moreau (1919) and Roubier (1920) have pointed out the difficulties in detecting the disease among black troops even when the patients are greatly infected, and they prove the value of radiological examination in such cases.

The same difficulties are experienced in the Sudan, especially as regards pulmonary tuberculosis, and it may not be amiss to mention here that the disease is at times simulated by bronchial spirochaetosis and a bronchitis of streptococcal origin.

The predisposing causes to tuberculosis in the Sudan have already been referred to, and there is no doubt that overcrowding

and the filthy habit of expectoration are the determining factors concerned with the spread of the disease, more especially in the cold winter months when overcrowding to the exclusion of light and air favour the possibilities of 'massed infection.' Scott's (1921) observations equally emphasize the rôle played by overcrowding and expectoration as causative factors in tuberculosis among the Chinese in Hong Kong.

The view that infected milk is a cause of tuberculosis in the Sudan may readily be dismissed; it is true that goats' milk, cows' milk, and to a less extent camels' milk, represent an important feature in the dietary of the natives of the country; nevertheless, tubercular disease of these animals is unknown. Many years ago the writer (1910) recorded a case in which acid-fast bacilli were found in lesions of the lung of a camel simulating miliary tuberculosis, but it should be stated that the possibility of these lesions being caused by an organism of the streptothrix or *nocardia* group could not be excluded.

From the evidence obtained it would appear that inhalation is the common method of infection, such infection arising from dust-infected particles. Once tuberculosis is established in the lung, dust appears to be an irritating factor favouring the progress of the disease; incidentally it may be mentioned here that the practice of recommending cases of early tuberculosis to a country such as the Sudan is one to be deprecated inasmuch as they invariably become worse.

With regard to sex and age, the disease appears to be more prevalent among adult males, but allowance should be made for the fact that racial customs, more especially in some parts of the Sudan, do not encourage the female population to seek medical advice; however, having due regard to this, it would appear that the disease is more prevalent among the itinerant male population, a fact which is not in accordance with Lankester's (1920) observations in India. The children of the Sudanese appear to be rarely affected.

Of the varieties of tubercular disease in the Sudan, adenitis is perhaps the commonest; with lung tuberculosis, and a pleurisy of tubercular origin next in frequency; general miliary tuberculosis also occurs probably more commonly than is suspected, presenting with its pyrexia, cachexia, and splenomegaly, a clinical picture often

difficult of diagnosis and readily confused with other diseases. Pott's disease is exceedingly rare, and tubercular meningitis more so. It is doubtful whether skin tuberculosis exists. Cases labelled as such have, on bacteriological examination, proved to be early tubercular leprosy.

A few cases of joint tuberculosis have been observed by the writer, but are uncommon. Intestinal tuberculosis occurring as a primary affection of the intestines is exceedingly rare, as would be expected in a country where animal tuberculosis is non-existent.

Recently a case of breast tuberculosis came under the writer's observations, and as the disease is of sufficient rarity even in Western countries, a few detailed notes regarding this case are appended.

The patient was a Sudanese woman, about 40 years of age, hailing from the remote hilly districts of Kordofan, where she had spent the greater part of her life. She was married, and had a grown-up daughter who was in good health. According to her statement, her illness commenced some sixteen months ago with a painful swelling of the breast, which was not attributed to any injury received. The symptoms lasted for a period of twelve months and then subsided; however, about three months ago, she had recurring attacks of pain, and decided to come to Khartoum for treatment.

On admission to hospital her general condition was good, and during the few days prior to operation she showed a slight rise of temperature in the evenings.

On examination of the affected left breast, there was apparent a marked retraction of the nipple (Plate XII, fig. 1), but no evidence of ulceration or scar formation. On palpation, a nodular condition of the breast was detected. The nodules appeared to be located in the breast substance, were firm in consistency, and freely movable over the subjacent muscle tissue. The axillary lymphatic glands on the left side showed no appreciable enlargement, and were painless on palpation. The right breast appeared to be perfectly healthy.

Apart from the breast pain, the patient complained of no other symptoms. Examination of the lungs, heart and abdominal viscera revealed no abnormalities, nor were any enlargements of the cervical, subclavicular, mesenteric or groin glands detected. A total excision of the left breast was carried out, and some enlarged lymphatic nodes encountered during the operation were cleared away.

On sectioning the breast, numerous greyish-white, irregular-shaped nodules of various sizes were found scattered throughout the breast tissue (Plate XII, figs. 2 and 3). At the base of the nipple many of these nodules had coalesced and appeared to be fibrous. The majority of the nodules were firm in consistency; some, on the other hand, had broken down to form soft caseating masses, which could be readily shelled out of a capsule composed of dense fibrous tissue.

Subsequent histological examination of some of these nodules revealed their lymphatic structure.

The gross pathological appearances of the breast suggested tuberculosis in which fibrosis was a marked feature.

Film preparations of the broken down connecting débris were stained for the purpose of demonstrating tubercle bacilli, but with negative results.

Portions of the nodules with adjacent breast tissue were excised, fixed, embedded and sectioned for histological examination. Sections showed almost a complete absence of normal breast tissue. Necrotic foci of various sizes composed of granular amorphous material in which only a few nucleated cellular elements could be seen were scattered throughout the section. The larger foci, representing advanced caseous degeneration, were sharply demarcated by a zone of dense fibrous tissue. The smaller foci showed a pericellular reaction composed chiefly of lymphocytes and connective tissue cells, while scattered irregularly throughout the tissue were giant cells of Langerhams, containing six or more nuclei (Plate XII, fig. 4).

The blood vessels showed a periarteritis and also some thickening of the tunica media.

Sections of the lymphatic nodules showed well marked caseation with separative fibrotic changes and typical giant cell systems. The vessels here also showed a periarteritis and mesarteritis. Sections of the nodules were also stained by special methods to demonstrate tubercle bacilli, but with negative results.

REMARKS

There is little or no doubt that the case represented one of tuberculosis of the breast in which reparative changes of a fibrotic nature were a feature. Such changes probably accounted for tubercle

bacilli not being found in the sections and film preparations, and were also responsible for the marked retraction of the nipple.

It is to be regretted that no inoculation experiments were carried out, but in view of the reparative changes noted it is doubtful whether they would have led to a successful issue.

In all probability, the breast was secondarily infected via the lymphatics, although no primary focus of infection could be detected.

In view of its rarity, even in Western countries, the case appears worthy of record, and no similar case appears to have been previously reported from the Sudan.

I am indebted to Dr. Hodson, M.V.O., Director, Khartoum and Omdurman Civil Hospitals, for furnishing the clinical notes of the case and for providing the material for examination.

KHARTOUM,
June 1, 1922.

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EXPLANATION OF PLATE XII

Fig. 1. Anterior view of the affected breast showing in the centre the marked retraction of the nipple.

Fig. 2. Section of the same breast showing the tubercular nodules demarcated by fibrous tissue.

Fig. 3. Showing a large caseating lymphatic node at the breast margin.

Fig. 4. Microphotograph of a section showing a single tubercle. In the centre is a giant cell sending protoplasmic processes into the surrounding epithelioid cells. The marginal portion of the tubercle shows the lymphoid cell infiltration. × 170.

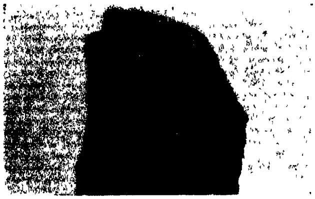


Fig. 1

Fig. 2

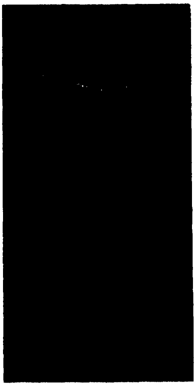


Fig. 3

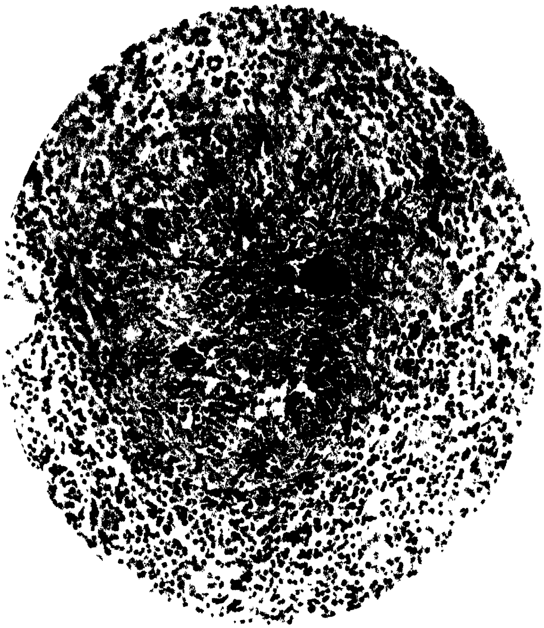


Fig. 4.

C. Tinling & Co., Ltd., Imp.

WEST AFRICAN CERATOPOGONINAE

PART II

BY

A. INGRAM

AND

J. W. S. MACFIE

(*Received for publication* 28 *June*, 1922)

The majority of the species described in this paper were collected at or near Accra, in the Gold Coast. A few, however, were sent to us from Nigeria, and for these we have to thank Dr. E. C. Braithwaite, of Calabar, and, once again, Dr. H. Andrew Foy, of Lagos.

With regard to the species which in this and our previous papers we have assigned to the Genus *Atrichopogon*, it should be noted that the eyes are not bare. In his paper on the 'Chironomidae of America' (1917), Kieffer associated his Genus *Kempia* with *Atrichopogon*, separting it by the pubescence of the eyes. Later (1921), in a brief note, the same author erected the new Genus *Gymnohelea*, the characters of which also agree with those of *Atrichopogon* excepting that the eyes are pubescent. Kieffer appears therefore, to recognise two genera (*Kempia* and *Gymnohelea*) closely allied to *Atrichopogon* but differing from it in having the eyes pubescent, but he has not stated what are the differences between them, nor indeed, so far as we can ascertain, has he fully detailed the generic characters of either. In the species which we have described, we have found every gradation between those in which the eyes are practically bare and those in which they are densely hairy. In the former, the pubescence may be restricted to the anterior margins of the middle thirds of the eyes and may be visible clearly only after treatment with caustic potash, so that it might be overlooked (as was done by us in some cases) unless, by rolling the specimen from side to side as is possible by our carbolic

technique, the whole eye were carefully examined.* In our opinion, the hairiness of the eyes cannot, therefore, be considered of more than specific value, and accordingly we have referred our species to the Genus *Atrichopogon*. The species which on a previous occasion (1921) we described as *Kempia ochrosoma* should also, we consider, be referred to this genus.

The figures illustrating the specific descriptions are in most cases mere outlines, drawn with the aid of a camera lucida, omitting such structures as the hairs on the hypopygium, and the fringe and the stronger setae on the costa and basal veins of the wings. The unit of measurement referred to is $3 \cdot 8\mu$.

The types and co-types of the new species described have been deposited in the Museum of the Liverpool School of Tropical Medicine.

Thysanognathus† (*Prionognathus*) *albopictus*, sp. nov.

MEASUREMENTS.	Male.	Female.
Length of body‡ (one male and one female) ...	1·2 mm.	1·3 mm.
Length of wing	0·9 mm.	0·9 mm.
Greatest breadth of wing	0·23 mm.	0·4 mm.

Head dark brown. Eyes narrowly separated above in the female, more widely in the male; in both sexes the space between them wedge-shaped, broadest at the vertex. Clypeus and proboscis dark brown. Palpi dark brown: in the female, the second and fourth segments sub-equal but the fourth the more slender, third rather longer, slightly inflated, with a large pit containing very long sensory hairs, fifth longer than the third, slightly dilated at its end; in the male, second, third, and fourth sub-equal, third not inflated, fifth longer and slightly dilated at its end. *Antennae*: in the female, first segment brown, bearing a few hairs, torus brown, rounded, bearing a few hairs; flagellum pale brown basally and darker brown apically, its segments somewhat flask-shaped, all

* Referring to this question Mr. F. W. Edwards has written to us as follows: '*Ceratopogon fusculus*, Coq., which I believe is the type of *Atrichopogon*, certainly has the eyes entirely bare, but like you, I have found species of this group which have the eyes only very slightly hairy on the upper part, and bare below. In consequence of this, I have long been of the opinion that *Atrichopogon* and *Kempia* ought to be united.'

† Mr. F. W. Edwards has kindly informed us that a new name is required for this genus as *Prionognathus*, C. I. and M. is preoccupied. See Scudder's *Nomenclator*.

‡ In all cases this measurement is taken from the anterior margin of the thorax to the tip of the abdomen of specimens mounted in carbolic.

about twice as long as broad, and forming a continuous series from base to apex, the last segment being slightly longer and broader, not flask-shaped, ending bluntly without a stylet. In the male, first segment a mere ring of chitin; torus brown, large, bearing a few hairs; flagellum pale brown basally, bearing a pale brown plume, and dark brown distally, the twelfth segment slightly produced distally, length about twice the breadth, the last three segments elongated, nearly five times as long as broad, the last segment ending bluntly without a stylet. *Thorax* dark brown with pale, almost silvery, markings. Dorsum dark brown, with a broad median pale stripe, and on each side of it two small pale spots anteriorly and a larger, more diffuse pale area at the root of the wing. These pale markings are larger and more distinct in the male than they are in the female. Pleurae brown. Scutellum greyish-brown, containing an almost white pigment, bearing in both sexes four central bristles, two anterior and two marginal, the latter close together. Post-scutellum dark brown with two large pale, grey, patches anteriorly. *Wings* (fig. 1) hyaline, with two small, blackish spots, one covering

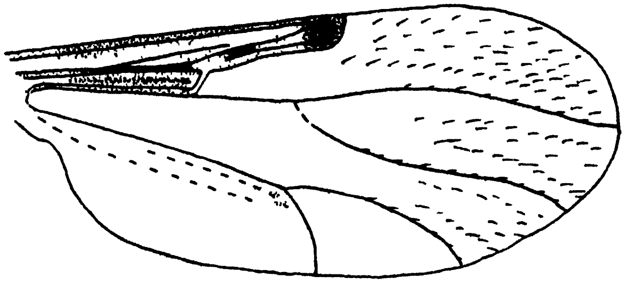


FIG. 1. *Thysanognathus (Prionognathus) albopictus*, sp.n., wing of female to show distribution of decumbent hairs, adornment, and venation. × c. 90.

the extremities of the costa and first and third veins, the other smaller about the middle of the fused portion of the first and third veins, covering only the anterior half of the vein. The anterior half of the basal portion of the wing proximal to the anterior cross-vein is also infuscated. These dark markings are much paler and less distinct in the male. Decumbent hairs fairly numerous in the female on the distal third of the wing at the tip, between the rami of the fourth vein, and (to a lesser extent) between the fourth and fifth veins; in the male they are entirely wanting. Halteres with greyish-brown,

almost white, knobs, paler in the male than in the female. The knobs contain a whiteish pigment similar to that present in the scutellum and in the abdomen. *Legs* in the female darkish brown, with pale bands; femora with pale sub-apical bands, tibiae with pale sub-basal bands, and on the middle and hind legs pale sub-apical bands also, first three tarsal segments pale, with slightly infuscated apices excepting the first tarsal segment of the hind legs which is entirely dark brown, fourth and fifth tarsal segments of all legs infuscated; in the male the legs are much paler, but similarly marked. Claws in the female unequal, one very large, about as long as the fifth tarsal segment, the other small, on the middle and hind legs about a quarter the length of the segment, on the fore legs longer, about half the length; in the male, claws equal, small, less than half the length of the fifth tarsal segment, with bifid tips. *Abdomen* dark brown with pale grey, almost silvery, markings on the sides and posterior margins of the segments. In the female the pale markings are somewhat broken up into small spots, and are most conspicuous on the fourth to the sixth segments; the tip of the abdomen is white. In the male the pale markings are larger or smaller marginal patches on each side of the middle line, and are most conspicuous on the fifth to the seventh segments; the tip of the body (excluding the claspers) is dark brown. Spermathecae two, highly chitinised, more or less pyriform and slightly unequal; in one specimen the lengths and breadths were about 80μ by 75μ, and 65μ by 68μ respectively. The chitinised parts of the ducts in the same specimen measured about 10μ and 8μ respectively, but as they merged insensibly with the bodies of the spermathecae the measurements are not exact ones.

HYPOPYGIUM (fig. 2). Highly chitinised, dark brown, excepting the claspers and the posterior end of the ninth tergite. *Ninth segment*: tergite long, broad and highly chitinised at the base, narrow and feebly chitinised at the apex, very sparsely clothed with hairs dorsally, the posterior margin straight, without either notch or lateral finger-like processes; sternite very deeply and widely excavated. *Forceps*: side-pieces well developed, highly chitinised, tapering distally; claspers very feebly chitinised and very pale coloured, curved slightly inwards, covered all over with minute hairs, and with the ends divided into two small processes, the ventral

one the larger and spine-like. *Harpes* very highly chitinised, distal portion directed posteriorly, broad at the base, tapering towards the

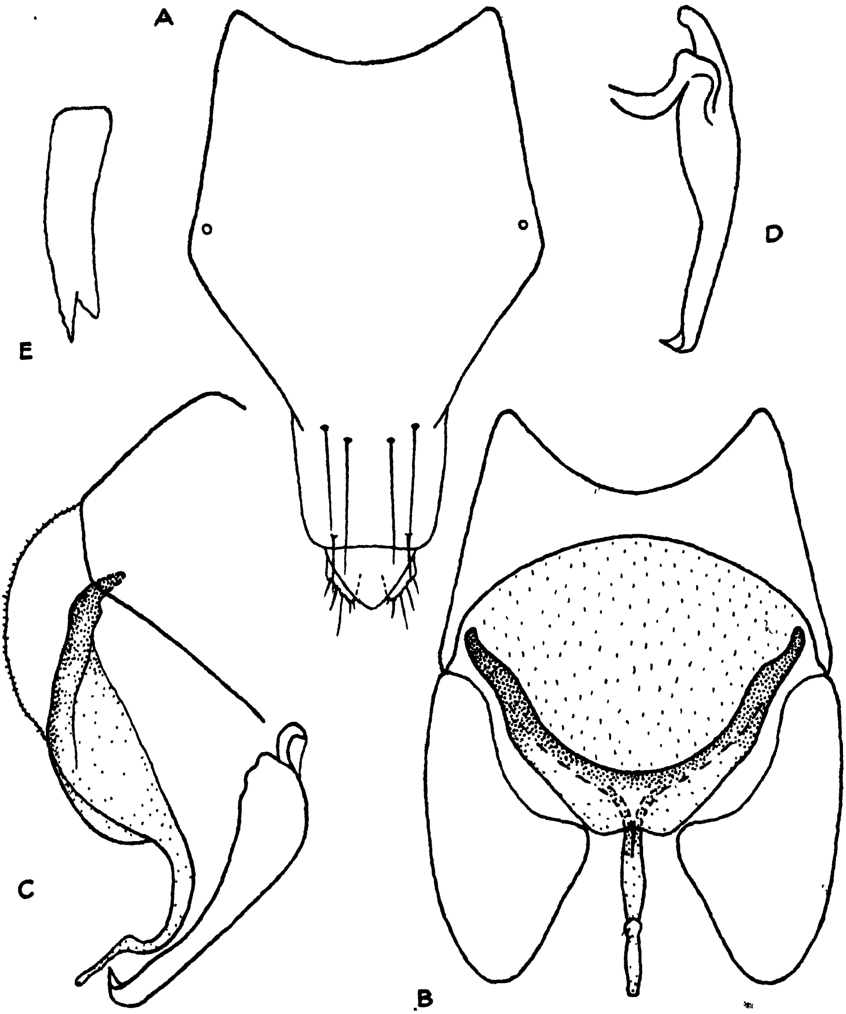


FIG. 2. *Thysanognathus* (*Prionognathus*) *albopictus*, sp.n., male hypopygium. *a*—ninth tergite, dorsal view; *b*—ninth sternite, side pieces, and aedoeagus, ventral view; *c*—aedoeagus and harpe, lateral view; *d*—harpe, ventral view; *e*—clasper, lateral view. All × c. 375.

apex, and ending in a short hook. *Aedoeagus* with a very wide basal arch and a long posterior process which is bent sharply at its

end in a ventral direction. Membrane joining the aedoeagus to the ninth sternite covered all over with spicules.

GOLD COAST: Dodowah, 18th February, 1922; two females and one male, reared from material taken from a rot-hole in a mango tree.

Thysanognathus (*Prionognathus*) *melanostictus*, sp. nov.

MEASUREMENTS.

Length of body (one male)	1·0 mm.
Length of wing	0·9 mm.
Greatest breadth of wing	0·3 mm.

Head brown. Eyes separated, the space between them being wedge-shaped, broadest at the vertex. Clypeus, proboscis, and palpi brown. Second, third, and fourth palpal segments sub-equal, fifth longer, slightly dilated distally. *Antennae*: torus very large, brown; flagellum unfortunately missing. *Thorax* greyish-brown with small dark brown spots. Scutellum greyish-brown, dark brown mesially, bearing four central bristles, two anterior and two marginal, the latter close together. Post-scutellum dark brown with two large pale grey areas anteriorly. Pleurae brown. *Wings* hyaline with small blackish spots as shown in the figure (see fig. 3). Decumbent

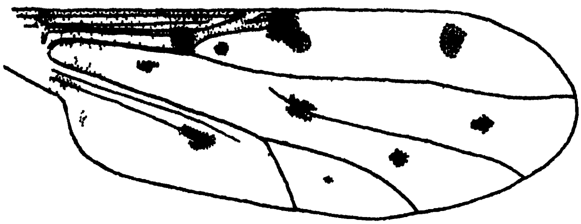


FIG. 3. *Thysanognathus* (*Prionognathus*) *melanostictus*, sp.n., wing of male to show adornment and venation. × c. 90.

hairs practically absent, only one or two being present at the periphery near the tips of the wings. Halteres with greyish-brown, almost white, knobs. *Legs* greyish-brown with dark markings similar to those of *P. marmoratus*. Claws similar to those of *P. marmoratus*. *Abdomen* dark brown with pale grey markings.

HYPOPYGIUM (fig. 4). Somewhat similar to that of *P. marmoratus*, not very highly chitinised. *Ninth segment*: tergite moderately long, feebly chitinised especially posteriorly, dorsal surface with six

long, strong hairs, three on each side in an oblique row, posterior margin rounded, not notched, with the lateral finger-like processes reduced to small elevations each bearing a short hair; sternite deeply excavated in the middle line posteriorly. *Forceps*: side-pieces well developed, highly chitinised especially at the base; claspers long, poorly chitinised, of almost uniform width throughout, basal three-quarters clothed with minute hairs. *Harpes* highly chitinised; basal

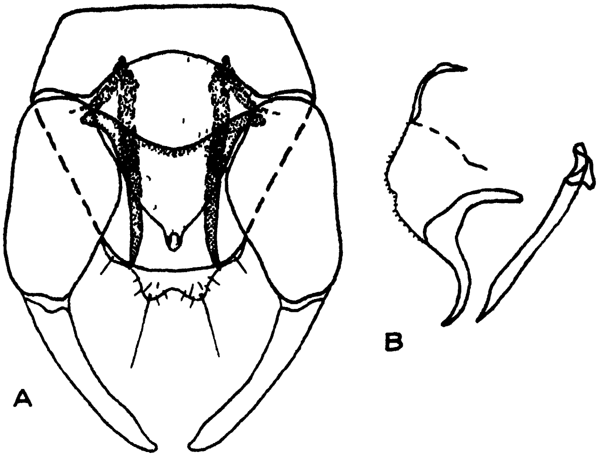


FIG. 4. *Thysanognathus* (*Prionognathus*) *melanostictus*, sp.n., male hypopygium. *A*—ventral view; *B*—lateral view of aedoeagus and harpe. × c. 375.

portion directed laterally; distal portion a long, almost straight, rod-like structure directed posteriorly, reaching to the posterior margin of the ninth tergite, and tapering to a point. *Aedoeagus* highly chitinised basally, curved, shaped as shown in the figures. Membrane connecting the aedoeagus to the ninth sternite covered with spicules.

GOLD COAST: Accra, February, 1922; a single male, collected upon a window in the laboratory.

Dasyhelea flavipicta, sp. nov.

MEASUREMENTS.

Length of body (two females)	0·9 mm.
Length of wing	0·7 mm.
Greatest breadth of wing	0·26 mm.

Head brownish-yellow, the middle of the occiput brown. Eyes narrowly separated. Clypeus brownish-yellow. Proboscis and

palpi brownish-yellow; third segment of palp cylindrical, not inflated, nearly as long as the fourth and fifth segments together, sensory hairs very few. *Antennae*: torus dark brown, flagellum paler brown, with conspicuous short and long spines on all the segments, and rather short brown hairs. First segment small, hairless; segments four to ten oval to elongate-ovoid, slightly constricted at the apex but not flask-shaped, the length varying from one and three-fifths to one and four-fifths the width; segments eleven to fifteen slightly longer and more flask-shaped, length from about twice to two and a half times the width, the last segment not ending in a stylet but tapering to a blunt point. *Thorax* bright yellow with dark brown dorsal bands similar to those of *D. flava* but darker and not distinctly separated. Scutellum (fig. 5) bright yellow, very slightly darker at the sides, with two lateral and four centro-marginal bristles and a single central-sub-marginal, small hair.

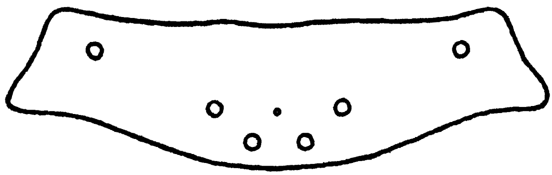


FIG. 5. *Dasybelea flavipicta*, sp.n., scutellum of female. × c. 375.

Post-scutellum dark brown. Pleurae yellow or yellowish-brown. *Wings* clear, without spots, rather thickly clothed with long decumbent hairs which extend to the base between the fourth and fifth veins. The bifurcation of the fourth vein before the middle of the wing, that of the fifth vein at about the same level as the end of the costa. Halteres with bright yellow knobs and brownish stems. *Legs* almost uniformly light brown; claws short, equal, simple. *Abdomen*: dorsum dark brown, venter paler, with yellow pigment (soluble in caustic potash) visible laterally and, when the abdomen is distended, between the segments. Spermathecae similar to that of *D. flava*, single, highly chitinised, pyriform, length about 45μ; the commencement of the duct is chitinised. Chitinous plates on the ventral aspect in the neighbourhood of the vulva unlike those of *D. flava*, and the tubular process present in that species apparently not developed (fig. 6).

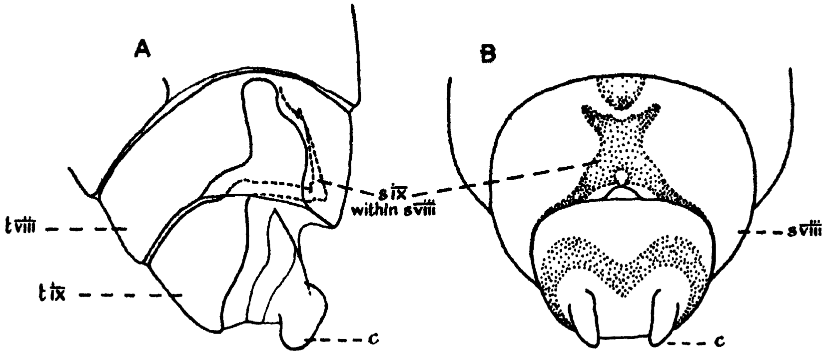


FIG. 6. *Dasyhelea flavipicta*, sp.n., posterior extremity of abdomen of female. *A*—lateral view; *B*—ventral view. × c. 280. *t*—tergite; *s*—sternite; *c*—cerci.

GOLD COAST: Accra, 8th March, 1920; collected in the evening upon windows in the laboratory. This species closely resembles *D. flava*, but is darker, and differs from it in the form of the antennal segments as well as in other respects.

Dasyhelea omoxantha, sp. nov.

MEASUREMENTS.	Female.	Male.
Length of body (one specimen of each)	1·2 mm.	1·2 mm.
Length of wing	0·9 mm.	0·9 mm.
Greatest breadth of wing	0·3 mm.	0·3 mm.

Head dark brown. Eyes narrowly separated in both sexes. Proboscis dark brown. Palpi paler brown; fifth segment swollen at the end, fourth slightly shorter than the fifth, third slightly longer and only feebly inflated in its lower half. *Antennae* dark brown, bearing dark brown hairs and, on segments four to ten of the flagellum at least, short and longer, curved, spines; in the female, segments four to ten sub-spherical to ovoid, length from a little over once to once and two-thirds the width, segments eleven to fourteen rather more elongate, length from a little over once and two-thirds to nearly twice the width, the last segment broad, without a stylet; in the male, segments four to eleven spheroidal to ovoid, segments twelve to fourteen elongated, sub-equal, about three times as long as broad, binodose, the last segment slightly shorter, broader at the base and tapering to a conical end without a stylet. *Thorax* dark

brown with large, yellow, humeral patches. Scutellum almost entirely yellow, but slightly darker at the sides, bearing in both sexes two lateral and three centro-marginal bristles and no small hairs. Post-scutellum dark brown. Pleurae yellow above, dark brown beneath. *Wings* without spots. Decumbent hairs in the female fairly numerous and extending as a row almost to the base between the fourth and fifth veins, in the male fewer, not extending basally beyond the level of the cross-vein, and absent from the anal angle and the fork of the fifth vein. Costa not reaching as far as the middle of the wing in either sex; terminal cell well developed in the male but almost obsolete in the female. Fork of the fourth vein proximal to the middle of the wing in both sexes, that of the fifth vein in the female at about the level of the end of the costa, in the male slightly more distal. Halteres with pale yellow knobs. *Legs* brown, often a reddish colour, the proximal segments and the joints slightly darker; claws small, simple, equal, with a slight basal extension, and in the male with bifid tips. *Abdomen* dark brown, venter paler than dorsum. Spermatheca single, highly chitinised, pyriform, length 32μ, greatest breadth 27μ, the duct chitinised for only about 2μ or less at its commencement.

HYPOPYGIUM (fig. 7). *Ninth segment*: tergite broad, tapering only slightly, and scantily clothed with long, dark hairs, especially

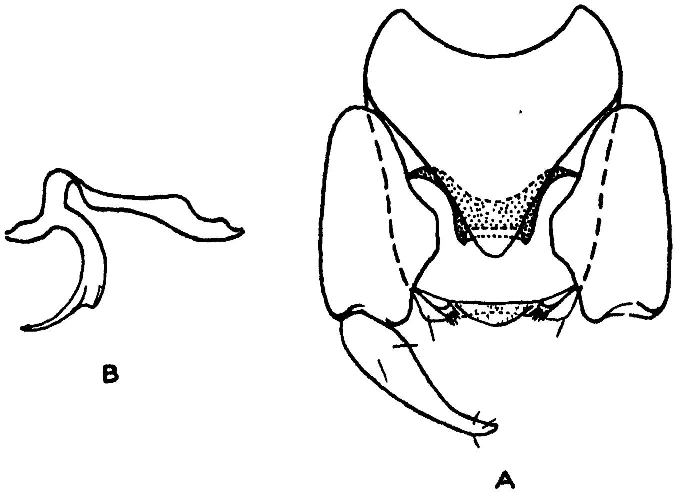


FIG. 7. *Dasybelea omoxantha*, sp.n., outlines of male hypopygium, ventral views. *A*—ninth segment, forceps, and aedoeagus; *B*—harpes. × c. 375.

in the middle line on the posterior quarter, posterior margin not notched, lateral angles squared, each with a single small hair and, more ventrally, a small process directed somewhat inwards and covered with short, stiff, hairs; sternite apparently prolonged posteriorly in the middle line as a delicate, more or less conical process. *Forceps*: side-pieces well developed, hairy; claspers single, rather highly chitinised; pubescent all over, and bearing in addition a few larger hairs at the base and apex. *Harpes*: basal portions very unequal and highly chitinised, appearance very variable in different specimens; from the right basal portion arises a long posterior projection which ends in a long pointed tip. *Aedoeagus* forming a broad, highly chitinised arch with a short posterior projection on each side.

NIGERIA (Southern Provinces): Calabar, February, 1922; one female and three males (Dr. E. C. Braithwaite). This species resembles in some respects both *D. luteoscutellata* and *D. inconspicuosa*, especially the former, but may be distinguished by the colour of the halteres and by the large, yellow, humeral patches. The hypopygium of the male is characteristic.

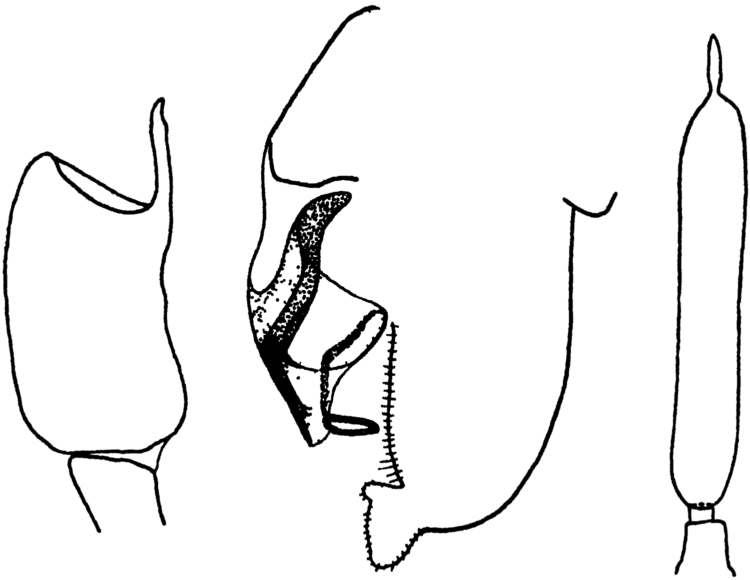
Atrichopogon africanum, Ingram and Macfie

MEASUREMENTS.

Length of body (one male)	1·7 mm.
Length of wing	1·3 mm.
Greatest breadth of wing	0·4 mm.

Head dark brown, clothed with dark brown hairs. Eyes pubescent, rather sparsely and apparently only on the upper halves; contiguous but with the facets narrowly separated. Clypeus, palpi, and proboscis dark brown. First palpal segment small, second about as long as the fifth, third longer, somewhat inflated, and bearing a well developed sensory cup at about its middle, fourth about half the length of the third, and fifth rather longer than the fourth and only slightly expanded at its end. *Antennae*: first segment and torus dark brown, the former a mere ring of chitin, the latter large, very dark, hairless. Flagellum paler brown, the terminal segments somewhat darker than the rest, with a well developed plume of brownish hairs. The twelfth segment is slightly prolonged at its distal end, length rather more than four times the

breadth, the last three segments elongated, about seven times as long as broad, the fourteenth being the shortest and the fifteenth the longest and ending in a long (about 20μ), pointed, stylet (fig. 8 *a*). The combined lengths of segments twelve to fifteen is rather greater than the combined lengths of segments four to eleven, namely (excluding the stylet, which measures about five units) 125 to 111, or 1·12 to 1. *Thorax* uniformly dark brown. Scutellum dark brown, bearing two admedian and two lateral bristles and



C B A

FIG. 8. *Atrichopogon africanum*, I. & M., *A*—outline of the last segment of the antenna of the male; *B*—hypopygium of male, aedoeagus in lateral view; *C*—side-piece to show the dorsal root-like process. All × c. 375.

about six small hairs. Post-scutellum dark brown. Pleurae dark brown. *Wings* clear, unspotted; surface covered by microtrichia but without longer decumbent hairs. Venation as in *A.* (*K.*) *ochrosoma.* Halteres with rather dark brown knobs. *Legs* almost uniformly brown, tarsal segments rather darker than the others, unarmed. Claws equal, small, about half the length of the fifth tarsal segment, bifid at the tips. Empodium well developed, hairy,

at least as long as the claws. *Abdomen* dark brown, but not so dark as the thorax.

HYPOPYGIUM (fig. 8, B and C, and fig. 9). Generally similar to that of *A.* (*K.*) *ochrosoma*. *Ninth segment* well chitinised: tergite long, bearing (especially on its posterior fourth) a number of strong hairs, posterior margin rounded, without lateral, finger-like processes; sternite deeply notched, bearing a few hairs. *Forceps* highly chitinised, normal in form; side-pieces with large, curved, dorsal root-like processes which articulate with the proximal ends of the aedoeagus; claspers rather strongly chitinised, entirely covered

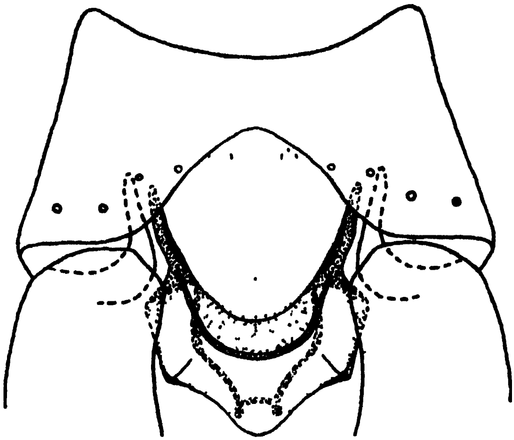


FIG. 9. *Atrichopogon africanum*, I. & M., part of male hypopygium, ventral view, showing the ninth sternite and the aedoeagus. × c. 375.

by pubescent hairs, and bearing in addition a few longer hairs. *Harpes* apparently wanting. *Aedoeagus* similar to that of *A.* (*K.*) *ochrosoma*, its form is somewhat variable, apparently depending on the degree to which it is protruded.

GOLD COAST: Accra; taken in the evening upon the windows of the laboratory. This insect resembles *Atrichopogon africanum*, I. and M., of which only the female is known, and we have, therefore, described it as the male of that species. It should be made clear, however, that this association is not without doubt, and may subsequently require correction.

Atrichopogon chrysospherotum, I. and M.

MEASUREMENTS.

Length of body (one male)	1·1 mm.
Length of wing	0·9 mm.
Greatest breadth of wing	0·26 mm.

This male insect resembles the female of *A. chrysospherotum* in most respects; the following characters, including the points of difference, may, however, be noted.

Head: eyes very sparsely hairy as in the female, the pubescence being most distinct at the sides near the anterior margin; contiguous above but with the facets narrowly separated. First palpal segment small, second and third sub-equal and rather small, the third only slightly inflated and with quite a minute sensory pit, fourth slightly shorter and broader than the third, fifth still smaller, with a rounded and undilated end (see fig. 10 C). *Antennae*: first segment a mere

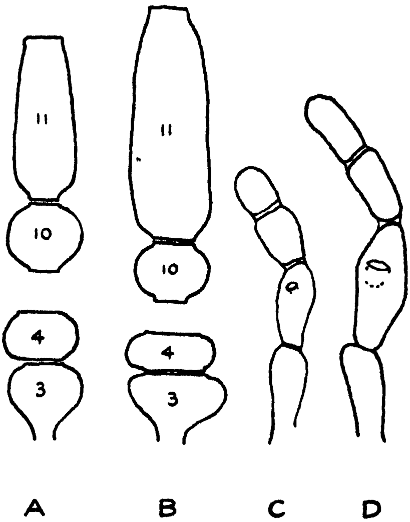


FIG. 10. Third and fourth and tenth and eleventh segments of the antenna of the female: *A—Atrichopogon chrysospherotum*; *B—Atrichopogon homoium*. (× 375.) Last four segments of the palp of the male; *C—A. chrysospherotum*; *D—A. homoium*. (× 375.)

ring of chitin without hairs; torus large, dark brown, bearing one or two hairs; flagellum darkish brown, the last three segments darker than the rest. The twelfth segment is only slightly produced distally, length about three times the breadth; the last three segments

elongated, sub-equal, about five times as long as broad, the fifteenth somewhat wider than the other two and ending in a long stylet of the usual form. The combined lengths of segments twelve to fifteen only slightly greater than the combined lengths of segments four to eleven, namely (excluding the stylet which measures about four units or 15μ), 77 units to 75, or 1·02 to 1. *Thorax*: scutellum without small hairs. *Wings* covered by microtrichia, but without longer, decumbent hairs. Halteres with yellow knobs, rather paler than in the female. *Legs* as in the female; claws equal, small, about half the length of the fifth tarsal segment, simple, bifid at the tips. Empodium hairy, large, as long as the claws. *Abdomen* darkish brown, containing a substance of a yellow colour which is soluble in caustic potash but not in carbolic acid.

HYPOPYGIUM (figs. 11, A and B). Highly chitinised, closely resembling that of *A. homoium*, the main point of distinction being

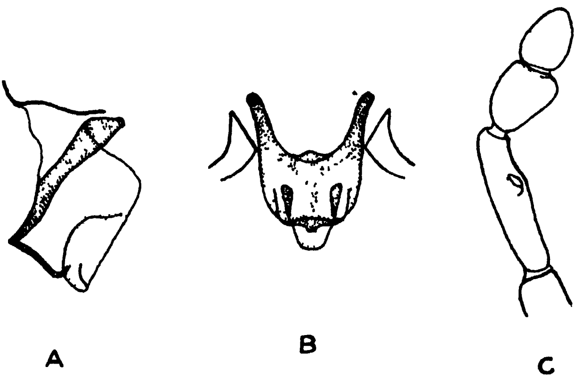


FIG. 11. *Atrichopogon chrysospherotum*, I. & M., aedoeagus. *A*—lateral view; *B*—ventral view. *Atrichopogon acanthocolpum*, sp.n. *C*—last three segments of palp of female. All × c. 375.

the aedoeagous, the form of which in ventral and lateral views is shown in the figures.

GOLD COAST: Accra, 1921; taken in the evening upon a window in the laboratory. This insect resembles *A. chrysospherotum*, and is, therefore, described here as the male of that species. It should, however, be clearly understood that this association is merely conjectural, and may or may not be confirmed by further experience.

Atrichopogon homoium, I. and M.

An examination of further specimens of this species enables us to add one or two points to our previous description of the female.

Head: eyes, as in *A. chrysospherotum*, sparsely hairy, the pubescence being most distinct laterally near the anterior margin; contiguous but with the facets narrowly separated. Third palpal segment (fig. 10 D) rather longer than in *A. chrysospherotum*, and about once and one-third the length of either the second or fourth segments. *Antennae*: as in *A. chrysospherotum*, the first segment is large and bears several hairs, and the torus is roughly spherical and also bears a few hairs. In both *A. chrysospherotum* and *A. homoium* segments four to ten are broad and short (fig. 10, A and B), but in the latter the basal ones are rather broader, the fourth segment, for example, measuring in one instance 4 by 9 units, as compared with 4 by 7 in the former. The last five segments range in length from about two and a half to nearly three times the breadth in *A. chysospherotum*, and from about three to over five times the breadth in *A. homoium*. The basal segments of the flagellum in *A. homoium* are shorter and broader, and the apical segments are more elongated than in *A. chrysospherotum*, the ratio of the combined lengths of segments four to ten to the combined lengths of segments eleven to fifteen being in one instance 34 to 115 units (1 to 3·4) in the former, and 36 to 91 units (1 to 2·5) in the latter. In these measurements the stylet (which measures about three units in the former and four in the latter) is not included. *Wings*: the decumbent hairs near the tip of the wing are rather variable, in one of our specimens there were eight on one wing and twelve on the other; there may be no decumbent hairs between the rami of the fourth vein.

We are also now able to give a description of the male.

MEASUREMENTS.

Length of body (one male)	1·3 mm.
Length of wing	1·0 mm.
Greatest breadth of wing	0·3 mm.

The male is in most respects similar to the female, but the following points may be noted. *Head*: eyes as in the female. Palpi as in the female. *Antennae*: first segment a mere ring of

chitin, without hairs; torus large, dark brown, bearing one or two hairs; flagellum pale brown basally, the last three segments dark brown. The twelfth segment is only slightly elongated, length about three times the breadth; the last three segments are more elongated, sub-equal, about six times as long as broad, the fifteenth segment ending in a long stylet. The combined length of segments twelve to fifteen considerably greater than that of segments four to eleven, namely (excluding the stylet which measures about four units, or 15μ), 107 units to 77, or 1·4 to 1. *Thorax*: scutellum bearing, in addition to the setae, apparently only two small hairs, one on each side. *Wings* longer and narrower than in the female, and without decumbent hairs. Halteres with yellow knobs, rather paler than in the female. *Legs* as in the female: first tarsal segments of the hind legs not quite three times the length of the second. Claws small, equal, with bifid ends.

HYPOPYGIUM (fig. 12 A and B). *Ninth segment* well chitinised: tergite long, sparsely clothed with long, dark-brown hairs which

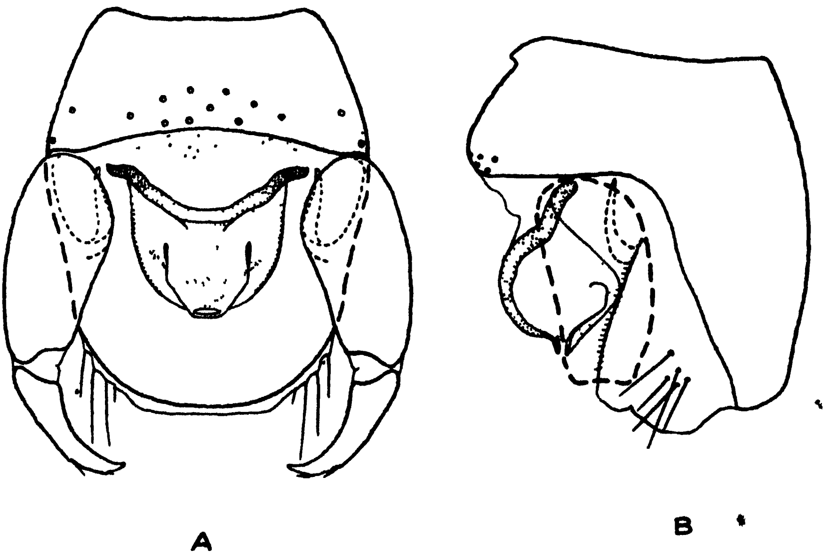


FIG. 12. *Atrichopogon homoium*, I. & M., outlines of male hypopygium. *A*—ventral view; *B*—lateral view. × c. 375.

are most numerous on the posterior fourth, posterior margin rounded, without a notch and without lateral finger-like processes; sternite hardly at all excavated in the middle line posteriorly, but bearing a

group of about ten stout hairs in this position. Membrane connecting the ninth sternite with the aedoeagus studded with small spicules on its anterior half. *Forceps* normal, not very highly chitinised. *Harpes* apparently absent. *Aedoeagus* of characteristic form (see fig. 12 A and B), proximal arch low, wide, feebly chitinised in the middle.

GOLD COAST: Accra, 10th December, 1921; two females, taken in the evening upon a window in the laboratory. Aburi, 3rd December, 1921; one male and one female, reared from material from a dead tree.

Atrichopogon acanthocolpum, sp. nov.

MEASUREMENTS.

Length of body (one female)	1·0 mm.
Length of wing	0·9 mm.
Greatest breadth of wing	0·37 mm.

Head very dark brown. Eyes densely hairy all over; contiguous above but with the facets rather widely separated. Clypeus, proboscis, and palpi dark brown. First palpal segment relatively long, second and fourth sub-equal, the former being slightly the longer and the latter being unusually broad, third segment about twice the length of the fourth, narrow, only very slightly inflated, and bearing a small sensory pit, fifth shorter than the fourth, narrowed at its distal end, not dilated (fig. 11 C). *Antennae* very dark and bearing short, dark brown hairs: first segment well developed, bearing a few hairs; torus very dark brown, bearing a few hairs; flagellum dark brown, segments four to ten sub-equal, sub-spherical, segments eleven to fifteen elongated, sub-equal, about three times as long as broad, the eleventh segment being slightly the shortest, the fifteenth slightly the longest and broadest and terminating in a long stylet. The combined lengths of segments eleven to fifteen (excluding the stylet) over twice the combined lengths of segments four to ten, namely, 93 units to 43, or 2·1 to 1. *Thorax* very dark brown, with a narrow, paler, sub-lateral line on each side, which expands posteriorly just before the scutellum into a pale patch. Scutellum dark brown, bearing two admedian bristles and two small hairs in place of the lateral bristles. Post-scutellum and pleurae dark brown. *Wings* clear, unspotted, covered by micro-

trichia but without longer, decumbent, hairs. Venation similar to that of *A. africanum*, but both radial cells narrow, slit-like, almost obsolete. Halteres almost colourless in the specimen when examined, that is, after preservation in alcohol. *Legs* yellowish-brown, tarsal segments somewhat darker. Femora and tibia rather sparsely clothed with hairs and with unarmed shafts. First tarsal segment of the hind legs about two and a half times the length of the second. Fourth tarsal segment bell-shaped. Claws equal, small, about half the length of the fifth tarsal segment, with a small notch about the middle. Empodium hairy, as long as the claws. *Abdomen* darkish brown, venter paler than the dorsum: in the neighbourhood of the genital opening is an armature of stout spines, namely, a single stout median spine terminating in several small sharp points on the posterior margin of the seventh sternite, a transverse, comb-like, row of stout, relatively blunt, spines on the eighth sternite, composed of about seven spines on each side, and just posterior to this row, two lateral patches, each of about a dozen similar but rather smaller spines. Spermatheca single, highly chitinised, pyriform, with 'pale spots' at the base; length about 85μ, greatest breadth about 60μ, the commencement of the duct chitinised for a short distance, about 8μ.

NIGERIA, Southern Provinces: Calabar, February, 1922 (Dr. E. C. Braithwaite).

Atrichopogon kelainosoma, sp. nov.

MEASUREMENTS.

Length of body (one male)	1·8 mm.
Length of wing	1·3 mm.
Greatest breadth of wing	0·4 mm.

Head dark brown, clothed with dark brown hairs. Eyes hairy, the pubescence, however, almost restricted to the lateral portions of the anterior borders; contiguous, but with the facets narrowly separated. Clypeus, palpi, and proboscis dark brown. First palpal segment small but distinct, second and fourth about the same size, third longer, about once and a half the length of the fourth, slightly inflated in the middle and furnished with a deep sensory pit, fifth slightly longer than the fourth and only slightly dilated at its end. *Antennae* rather dark brown with large plumes of brown

hairs: first segment a mere ring of chitin; torus large, dark brown, bearing one or two hairs; flagellum paler brown and almost unicolourous, the twelfth segment somewhat produced distally, length about four times the breadth, the last three segments elongated, about seven to eight times as long as broad, the fourteenth being the shortest, and the fifteenth slightly the longest and ending in a long stylet. The combined lengths of segments twelve to fifteen is considerably greater than that of segments four to eleven, namely (excluding the stylet, which is about five units long), 131 units to 96, or 1·36 to 1. *Thorax* uniformly dark brown. Scutellum dark brown, bearing two admedian and two lateral bristles and four small hairs. Post-scutellum dark brown. Pleurae dark brown. *Wings* clear, unspotted, without decumbent hairs. Venation as in *A. africanum*. Halteres with darkish brown knobs. *Legs* almost uniformly brown, tarsal segments, however, rather darker than the rest, unarmed. Claws equal, small, about half the length of the fifth tarsal segment, with a slight indication of a notch, and with bifid tips. Empodium well developed, hairy; at least as long as the claws. *Abdomen* dark brown, but not so dark as the thorax.

HYPOPYGIUM (fig. 13). Similar to that of *Atrichopogon africanum*. *Ninth segment* well chitinised: tergite as in

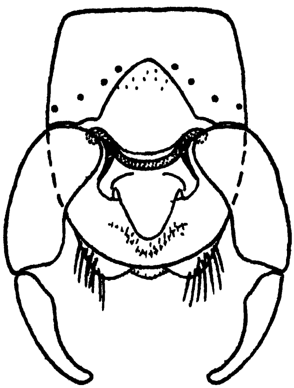


FIG. 13. *Atrichopogon kelainosoma*, sp.n., outline of male hypopygium, ventral view. × c. 185.

A. africanum; sternite deeply excavated in the middle line posteriorly as in *A. africanum*, and bearing similar hairs, but with the small

spicules extending right across the apex of the notch. *Forceps* highly chitinised, similar to those of *A. africanum*. Harpes apparently absent. *Aedoeagus* similar to that of *A. africanum* but differing in detail as shown in the figures.

GOLD COAST: Accra; taken in the evening upon a window in the laboratory. This species closely resembles *A. africanum*, but may be distinguished by the following amongst other characters: the lesser degree of hairiness of the eyes, the greater length of the fourth palpal segment, and the form of the aedoeagus.

Atrichopogon acosmetum, sp. nov.

MEASUREMENTS.

Length of body (two males)	1·5 mm.
Length of wing	1·2 mm.
Greatest breadth of wing	0·3 mm.

Head dark brown, clothed with dark brown hairs. Eyes pubescent, as in *A. kelainosoma*, especially at the sides near the anterior margin; contiguous, but with the facets narrowly separated. Clypeus, palpi, and proboscis dark brown. First palpal segment small, second and fourth sub-equal, fifth about the same size or a little shorter and not expanded at its end, third about one and a half times the length of the fourth, inflated in the middle, and furnished with a well-developed sensory pit. *Antennae* rather dark, with plumes of darkish-brown hairs; first segment a mere ring of chitin; torus large, dark brown; flagellum segments paler brown, excepting the last four which are darkish brown. The twelfth segment is somewhat produced distally, length rather more than three times the breadth; the last three segments are elongated, sub-equal, about six times as long as broad, the fifteenth segment being slightly the longest and ending in a long stylet. The combined lengths of segments twelve to fifteen slightly greater than that of segments four to eleven, namely (excluding the stylet which measures about five units, or about 20μ), 107 to 90 units, or 1·18 to 1. *Thorax* dark brown, with a small pale spot on each side immediately in front of the scutellum near its lateral margins, and with two conspicuous long hairs, one on each side, a little in front of them. Scutellum dark brown, bearing two lateral and two admedian bristles and one or two small hairs. Post-scutellum dark brown.

Pleurae dark brown. *Wings* clear, unspotted; surface covered by microtrichia, but without longer decumbent hairs. Venation as in *A. africanum*, first radial cell small and slit-like. Halteres with cream-coloured or whiteish, slightly infuscated, knobs. *Legs* brown or yellowish-brown, tarsal segments darker than the others. Claws small, about half the length of the fifth tarsal segment, equal, with a small barb, and with bifid tips. Empodium well developed, hairy, as long as the claws. *Abdomen* darkish brown.

HYPOPYGIUM (fig. 14). Closely resembling that of *A. africanum*. *Ninth segment* well chitinised: tergite long, sparsely clothed with long, dark hairs, posterior margin rounded, without a notch and

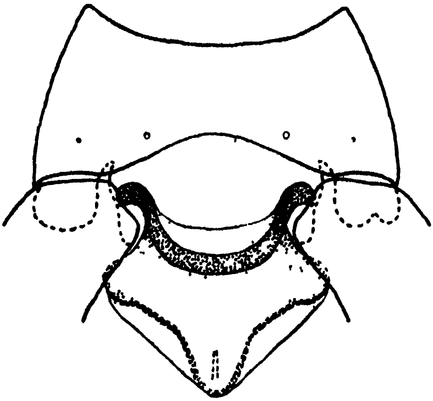


FIG. 14. *Atrichopogon acosmetum*, sp.n., part of male hypopygium, ventral view, showing ninth sternite and aedoeagus. × c. 375.

without lateral finger-like processes; sternite notched in the middle line posteriorly, but not so deeply as in *A. africanum*, bearing one or two hairs on each side of the notch. Membrane joining the ninth sternite to the aedoeagus studded with spicules on that part which occupies the apex of the notch. *Forceps* highly chitinised, normal in form; dorsal root-like processes of the side-pieces shorter than in *A. africanum*. *Harpes* apparently wanting. *Aedoeagus* similar to that of *A. kelainosoma*.

GOLD COAST: Accra, 24th December, 1921, and upon an unknown date in 1920; two males taken in the evening upon windows of the laboratory. This species closely resembles *A. kelainosoma*, but is smaller, and may be distinguished from it by the colour of the

halteres and the details of the hypopygium as well as by other characters.

We also collected in the Accra laboratory a single specimen of a midge which was probably the female of this species. The specimen is unfortunately imperfect. The following is a brief description of it:—

MEASUREMENTS.

Length of body (one female)	1·4 mm.
Length of wing ... ..., ...	1·0 mm.
Greatest breadth of wing	0·4 mm.

Head dark brown, clothed with dark brown hairs. Eyes very sparsely hairy, the pubescence being most distinct at the sides near the anterior margin; contiguous above but with the facets narrowly separated. Clypeus, palpi and proboscis brown. First palpal segment small, second rather longer than the fourth, third about once and a half the length of the fourth, somewhat inflated, with a large sensory pit. fifth shorter than the fourth, with a rounded end which is not dilated. *Antennae*: first segment large, bearing a few hairs; torus dark brown, more or less rounded, bearing a few hairs; flagellum unfortunately missing. *Thorax* dark brown. Scutellum dark brown, bearing two lateral and two admedian bristles, and four small hairs (two on each side). Post-scutellum dark brown. Pleurae dark brown. Wings clear, unspotted, covered by microtrichia; three or four longer decumbent hairs near the tip of the wing and about a dozen along the upper ramus of the fourth vein on its distal portion, but no decumbent hairs on the other parts of the wing surface. Venation as in *A. africanum*. Halteres with white knobs which have a pale-yellowish tint. *Legs* almost uniformly yellowish-brown; first tarsal segment of the hind legs nearly three times as long as the second; claws equal, small, about half the length of the fifth tarsal segment, with a small barb. Empodium hairy, long, at least as long as the claws. *Abdomen* dark brown, venter rather paler than dorsum. Spermatheca single, highly chitinised, oval, measuring about 46μ by 42μ, the duct chitinised for only a very short distance (about 2μ) at its commencement.

GOLD COAST: Accra, 1921; a single female collected in the evening upon a window in the laboratory.

prosecution of carefully controlled transmission experiments, and all this frequently assumes enormous proportions. This is why the bulk of the existing knowledge concerning insect vectors of animal diseases relates to the mechanical, as opposed to the cyclical, method of transmission, and it will also be largely the former category of diseases that will be dealt with in the section that follows.

SOME COMMON INSECT-BORNE DISEASES OF LIVE-STOCK

It would hardly be possible within the compass of a note of this kind to deal, even in outline, with the whole of the enromous volume of accumulated evidence on record pointing to the conclusion that it is through the intermediary of insects that a large proportion of the pathogenic organisms are acquired by live-stock. In what follows it is proposed merely to cite, by way of illustration, a few of the more important diseases in which insect vectors are known or believed to be involved. For the sake of convenience, these diseases will be considered under four categories, depending upon the nature of the agents responsible for their causation and this will incidentally furnish an indication of the remarkably varied character of the rôle played by insects in their spread under natural conditions.[1]

(a) *Virus diseases*[2]

1. *Rinderpest.*—There is on record a good deal of presumptive evidence to indicate that this most serious contagious disease of cattle is spread through the intermediary of blood-sucking flies. The consistency with which the disease can be reproduced by the sub-inoculation of a minute quantity of infective blood is in itself suggestive of such a possibility and to this may be added the observations brought forward by some recent workers to show that outbreaks of rinderpest frequently synchronize with the seasonal occurrence of the larger types of biting flies [Crawford, 1933]. As a matter of fact, there are instances on record where the disease has been experimentally reproduced through the bites of tsetse flies in Africa [Hornby, 1926] and of horseflies in India [Bhatia, 1935].

2. *Fowl-pox.*—This is one of the few virus diseases which have been conclusively shown to be capable of being transmitted through the agency of insects. It has been recently demonstrated that under experimental conditions fowl-pox can be readily reproduced through the bites of various species of mosquitos, some of which are of common occurrence in India [Kligler, Mackenfuss and Rivers, 1929]. In a few instances, these mosquitos have been found to remain infective for about a fortnight following a meal on diseased fowls. It is noteworthy that the stable-fly has also proved capable of transmitting fowl-pox one to fifteen days after becoming infective [Bos, 1932].

(b) *Bacterial diseases*

3. *Anthrax.*—The earliest experimental evidence of the transmission of anthrax through the agency of insects was obtained as far back as in the year 1869,

[1] The general features of the vectors mentioned in this and the following section are indicated by diagrammatic sketches in Plate XVIII.

[2] These diseases are caused by agents which cannot be seen under the microscope.

when Raimbert showed that the disease could be reproduced by the inoculation into guinea-pigs of the crushed bodies of meat flies that had been fed on anthrax blood. Since that date, our knowledge of vectors concerned in the spread of this disease has steadily advanced, and of the more recent contributions in this field, mention may be made of those made by Morris [1918] in America, who succeeded in transmitting the disease through the agency of horseflies and mosquitos. The so-called carrion flies are also known to be not infrequently concerned in the spread of the disease under natural conditions, and this is only what is to be expected in view of their habit of breeding in carcases of animals, including those dead of anthrax. This was strikingly illustrated during the Great War when numerous cases of the disease occurred in animal subjects due to flies bred from infected carcases on the battlefield.

4. *Haemorrhagic septicaemia*.—Although no definite experimental evidence has as yet been put forward to prove the transmission of this disease through the agency of insects, there is a considerable amount of presumptive evidence on record pointing to the conclusion that, under natural conditions, the disease is conveyed by more than one species of biting flies, notably horseflies [Nieschulz and Kraneveld, 1929]. In view of the fact that the causal parasite of haemorrhagic septicaemia is a near relative of the bacillus of human plague, the possibility suggests itself, as already pointed out by Sen [1925], that fleas may also act as vectors of the disease.

(*c*) *Protozoan diseases*[1]

5. *Surra* (Trypanosoma evansi *infection*).—In relation to the question of vectors of animal diseases, the subject of surra has received by far the largest amount of attention from veterinary workers in India, the earliest observations in this field having been made as far back as in the year 1901, when Rogers brought forward some experimental evidence to prove that the disease was transmitted by the bites of horseflies. Rogers's observations have since been confirmed by a large number of other workers, not only in India, but also in the Philippines [Mitzmain, 1913] and Dutch East Indies [Nieschulz, 1930]. Of the Indian workers in this field, a special mention should be made of Cross and his collaborators [1922, 1923], who, as a result of an extensive series of experiments, came to the conclusion that the disease was capable of being transmitted by several species of horseflies, notably the one known as *Tabanus rubidus*, which is of very common occurrence in this country. At the present time, however, attention has been largely focussed on the possibility of the occurrence of a cyclical transmission of the disease on the analogy of what is known to take place in the

[1] The protozoa are 'unicellular' organisms and include the malaria parasites.

segment, bifid at the tips. Empodium rudimentary. *Abdomen* dark greenish-brown dorsally, excepting the first two segments which are pale; venter paler.

HYPOPYGIUM (fig. 16). *Ninth segment*: tergite sparsely clothed with long hairs, rather short, tapering slightly, the posterior margin rounded, notched, without lateral finger-like processes; sternite very

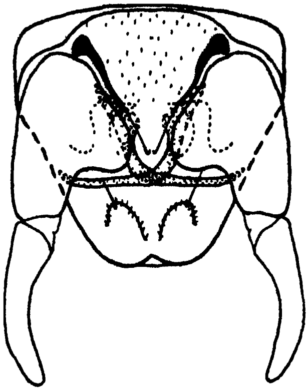


FIG. 16. *Stilobezzia limnopila*, sp.n., hypopygium of male, ventral view. × c. 375.

short, slightly excavated. *Forceps* feebly chitinised: side-pieces sparsely clothed with long hairs, each with a broad, inwardly-projecting, basal process, and a highly chitinised, beak-like, dorsal root-like process; claspers blunt, clothed with minute hairs and a few rather longer, delicate hairs. *Harpes* long, slender, highly chitinised, crossing in the middle line; basal portion foot-like, distal portion long, tapering gradually. *Aedoeagus* V-shaped, the membrane joining it to the ninth sternite spiculated.

GOLD COAST: Accra, 26th December, 1921; reared from mud from the margin of a pool near the station for the Weshiang Railway.

Monohelea nigeriae, sp. nov.

MEASUREMENTS.

Length of body (one female)	1·2 mm.
Length of wing	0·8 mm.
Greatest breadth of wing	0·3 mm.

This insect is generally similar to *Monohelea litoraurea*. *Head* dark brown. Eyes above widely separated posteriorly and just

touching anteriorly. Clypeus, proboscis, and palpi dark brown. Stylets of the proboscis highly chitinised, mandibles strongly serrated at their ends. First palpal segment very small, second and fourth sub-equal, third about once and a half the length of the fourth, inflated about its middle, bearing a large sensory pit, fifth slightly longer than the fourth, somewhat dilated at its end. *Antennae* brown: first segment rather large, darkish brown, bearing a few hairs; torus rounded, rather dark yellowish-brown, bearing a few hairs; flagellum paler brown, the distal halves of the basal segments and the whole of the last five segments darker. Segments four to ten almost sub-equal, about twice as long as broad or a little longer; segments eleven to fourteen elongated, about four times as long as broad, the last segment slightly longer (24 units by 5), tapering at its extremity. Combined lengths of segments eleven to fifteen rather greater than the combined lengths of segments four to ten, namely, about 106 units to 93, or 1·14 to 1. *Thorax* darkish brown. Scutellum darkish brown, darker in the centre and at the sides, bearing two admedian and two lateral bristles, and six short hairs. Post-scutellum dark brown. Pleurae dark brown. *Wings* (fig. 17)

FIG. 17. *Monobelea nigeriae*, sp.n., wing of female (fringe not shown). × c. 90.

brownish, markings somewhat similar to those of *M. litoraurea*, surface covered by microtrichia but without longer, decumbent hairs. Venation as shown in the figure. Halteres with dark brown knobs and pale stems. *Legs*: coxae, trochanters, femora, and tibiae on all the legs dark brown, with the exception of the knees which are pale, yellowish; tarsal segments pale brown, the first tarsal segments of the hind legs, however, rather darker than the others. Form of

the segments and armatures of spines as in *M. litoraurea*; fourth tarsal segments cylindrical. First tarsal segment of the hind legs two and a half times as long as the second, and with a double bend at the base. Claws on the fore and middle legs equal, rather long, about three-fifths the length of the fifth tarsal segment, each with a small basal tooth; on the hind legs single, longer (but not so long as in *M. litoraurea*), about as long as the fifth tarsal segment, with a basal tooth. Empodium rudimentary. *Abdomen* grey-brown with dark markings in the fresh state, almost uniformly dark brown after preservation; tip of the body pale, almost white. Spermathecae two, highly chitinised, oval or sub-spherical, unequal, diameters in the single specimen examined approximately 57μ by 45μ, and 50μ by 50μ the commencement of the duct chitinised for only a very short distance.

NIGERIA, Southern Provinces: Lagos, 26th November, 1921 (Dr. H. Andrew Foy); collected in the evening upon a lamp-shade.

Eukraiohelea foyi, sp. nov.

MEASUREMENTS.

Length of body (one female)	1·7 mm.
Length of wing	1·5 mm.
Greatest breadth of wing	0·5 mm.

This insect is grey, with brown markings, and in many respects resembles *Eukraiohelea africana*.

Head dark brown. Eyes bare, narrowly separated above. Clypeus, proboscis and palpi dark brown. Stylets of the proboscis very highly chitinised. First palpal segment very small, second and fourth sub-equal, cylindrical, third and fifth sub-equal, slightly longer than the fourth, the third only very slightly inflated and bearing a small sensory pit near its distal end, the fifth slightly longer and slightly dilated at its end. *Antennae* as in *E. africana*; combined lengths of segments eleven to fifteen (excluding the stylet which measures about four units, or 15μ) more than twice the combined lengths of segments four to ten, namely, about 253 units to 121, or 2·1 to 1. *Thorax* brown, darkest anteriorly. Scutellum brown, bearing two admedian and two lateral bristles and one small hair on each side. Post-scutellum dark brown. Pleurae grey: above the coxae of the fore and middle legs is a brown spot. *Wings*

clear, unspotted, covered by microtrichia but without decumbent hairs. Venation similar to that of *E. africana*, but the terminal part of the first vein and the anterior cross vein form an almost straight, though oblique, line, and the fork of the fourth vein is slightly distal to that of the fifth (fig. 18). Halteres with white knobs bearing a few small hairs; stalks brownish, bases of the knobs rather deeply infuscated. *Legs* pale brown, almost colourless, with dark brown knee-spots, the infuscation on the hind legs extending below the knee about one-third of the length of the tibiae, and dark brown apical spots on the fore and hind tibiae. Armature of spines and form of the segments as in *E. africana*. Claws as in *E. africana*. Empodium absent. *Abdomen* grey with brown dorsal markings, namely, on each side of segments two to six a broad L-shaped mark,

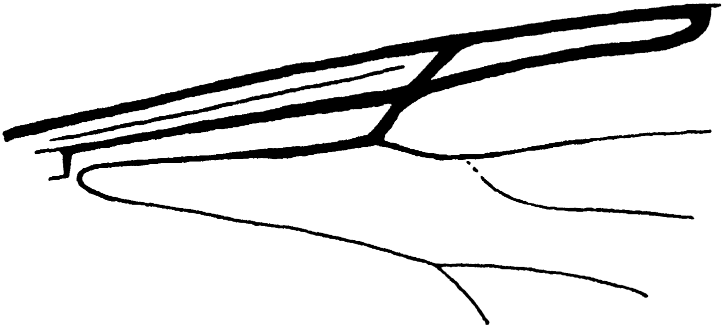


FIG. 18. *Eukraiobelea foyi*, sp.n., part of wing of female to show venation. × c. 90.

the vertical limbs being lateral and the horizontals reaching transversely towards the middle line but falling somewhat short of it. Spermathecae two, highly chitinised, pyriform, sub-equal; length about 59μ, greatest breadth about 43μ, the commencement of the duct chitinised for only a short distance, about 4μ.

NIGERIA, Southern Provinces: Lagos, November, 1921 (Dr. H. Andrew Foy); collected in the evening upon a lamp-shade. This insect, which is somewhat similarly coloured, may be distinguished from *E. versicolor* by, among other characters, the length of the last antennal segment, the abdominal markings, and the size of the spermathecae: it differs also from *E. africana*, notably in colour. We have pleasure in dedicating this species to the collector, Dr. H. Andrew Foy.

*Ankistrodactylus** (*Schizodactylus*) *par*, sp. nov.

MEASUREMENTS.

Length of body (one female)	4·5 mm.
Length of wing	2·8 mm.
Greatest breadth of wing	1·0 mm.

Head dark brown, wider than the thorax, flattened from before backwards. Eyes bare, narrowly separated above. Clypeus and proboscis darkish brown, the stylets of the proboscis highly chitinised. Palpi dark brown: first segment rudimentary, second, third and fifth sub-equal, fourth rather smaller; third segment not inflated and without a sensory pit, but bearing a patch of sensory hairs anteriorly, fifth cylindrical, not dilated at its end. *Antennae*: first segment bearing a few hairs; torus dark yellowish-brown, somewhat pyriform, bearing a few hairs; third segment rather longer than the following segments, with a short stalk; segments four to ten pale brown, distal portions of each slightly darker, bearing scanty hairs, sub-cylindrical, the middle slightly wider than the ends, length ranging from about twice to rather over three times the breadth; segments eleven to fifteen elongated, darkish brown excepting the basal sixths, the proximal four seven to eight times as long as broad, the fifteenth slightly longer, nearly ten times as long as broad, with a conical end without a stylet. The combined lengths of segments eleven to fifteen greater than the combined lengths of segments four to ten, namely, about 200 units to 130, or 1·5 to 1. *Thorax* greyish-pruinose, with two longitudinal darker, brownish, stripes on each side, one admedian and the other sub-lateral, the two admedian stripes converging anteriorly. In carbolic acid the thorax appears uniformly very dark brown. Hairs small and scanty. Pleurae dark brown. Scutellum dark brown, bearing numerous bristles and small hairs. Post-scutellum dark brown with a greyish pruinosity. *Wings* (fig. 19) brownish, especially anteriorly; venation and dark markings as shown in the figure. Fringe short. Wing surface covered by microtrichia but without longer, decumbent hairs. Halteres with yellowish- or orange-brown

* Mr. Edwards has kindly informed us that a new name is required for this genus as *Schizodactylus* is preoccupied. See Scudder's *Nomenclator*.

knobs. *Legs*: femora brown, proximal halves orange-brown, distal halves very dark brown and bearing numerous (a dozen or more) short, stout, black, ventral spines; fore femora slightly broader than the others. Tibiae on fore and middle legs yellowish-brown with infuscated apices and bases; hind tibiae entirely dark brown, and with a regular dorsal row of longish hairs. First four tarsal segments on all the legs pale brown, fifth very dark brown. First tarsal segment longer than the second on all the legs; fourth not cordiform. On the first tarsal segment of the middle legs and the second of the hind legs is a single longitudinal row of small spines; on the first tarsal segment of the hind legs is a double row of similar spines. The fifth tarsal segments on all the legs bear several (five

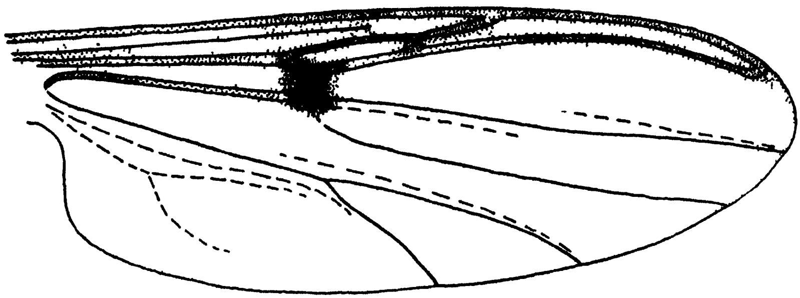


FIG. 19. *Ankistrodactylus (Schizodactylus) par*, sp.n., wing of female to show adornment and venation (fringe not shown). × c. 40.

or six) pairs of short, stout, black spines. Claws on all the legs equal, long, about as long as the fifth tarsal segment, with a rather large basal barb. Empodium rudimentary. *Abdomen* greyish-pruinose dorsally, each segment having at the base a darker, brownish, band which is narrow but expanded a little in the middle line, and bearing two small admedian brown spots on the posterior third; the second segment bears also two larger brown spots near its anterior lateral angles; darkish brown laterally; venter paler brown. Spermathecae two, very highly chitinised, oval, unequal, measuring in one specimen about 148μ by 106μ, and 122μ by 95μ; the duct chitinised for only a short distance, about 7μ, at its commencement.

GOLD COAST: Christiansborg, near Accra, 29th October, 1921; two females, reared from plants of *Pistia stratiotes*.

Palpomyia pistiae, sp. nov.

MEASUREMENTS.	Male.	Female.
Length of body (one male and one female) ...	3·6 mm.	5·6 mm.
Length of wing	2·3 mm.	4·3 mm.
Greatest breadth of wing	0·65 mm.	1·1 mm.

Head very dark brown. Eyes bare, in both sexes separated by a wedge-shaped space which is broadest at the vertex. Clypeus dark brown, hairy. Proboscis dark brown, short, labium fleshy; in the female, mandibles highly chitinised and strongly serrated. Palpi dark brown; first segment rudimentary, second and fourth sub-equal, third longer than the fourth, cylindrical, without a definite pit but with a small anterior depression from which arise a few sensory hairs, fifth segment the longest nearly twice the length of the fourth. *Antennae*: in the female, first segment darkish brown, bearing a few hairs; torus dark yellowish-brown, sub-spherical, bearing a few hairs; segments three to ten dark brown apically and pale brown basally, almost cylindrical, the third slightly longer than the succeeding segments, the fourth to the tenth sub-equal, about three times as long as broad; segments eleven to fifteen entirely dark brown, elongated, length ranging from about eleven to fifteen times the breadth, the last segment not ending in a stylet; the combined lengths of segments eleven to fifteen greater than the combined lengths of segments four to ten, namely, about 451 units to 210, or 2·1 to 1. In the male, torus larger and darker than in the female, basal segments of the flagellum rather pale brown, bearing a well-developed plume of pale brown hairs; segments four to eleven sub-equal and decreasing very slightly in size and gradually becoming darker from base towards the apex; twelfth segment all dark brown, about the same size as the eleventh; segments thirteen to fifteen completely dark brown, elongated, lengths respectively about seven, sixteen, and twenty-five times the breadths, the last segment without a stylet. *Thorax* uniformly very dark brown, bearing very small hairs, and a sharply pointed tubercle projecting forwards from the middle of the anterior margin. Pleurae very dark brown. Scutellum very dark brown, bearing in both sexes numerous short bristles and small hairs. Post-scutellum very dark brown. *Wings* (fig. 20) brownish, with darker markings as shown in the figure. Surface granular, but without either microtrichia or longer, decumbent hairs.

Fringe very short. Venation in the female as shown in the figure; in the male, second cell not so long, the third vein joining the costa a little further from the tip of the wing. Halteres with dark brown knobs. *Legs*: femora and tibiae almost uniformly very dark brown, but in the male the bases of the fore femora and the apices of the fore tibiae rather paler; the femora not swollen, and bearing ventrally on the apical halves of all the legs a few short, stout, black spines—in the male seven or eight on the fore legs and three on the middle and hind legs, in the female nine or ten on the fore, three or four on the middle, and four or five on the hind legs. First two tarsal segments yellowish-brown, third similarly coloured at its proximal end but infuscated distally, the fourth and the fifth entirely dark brown. First tarsal segment at least twice as long as the second on all

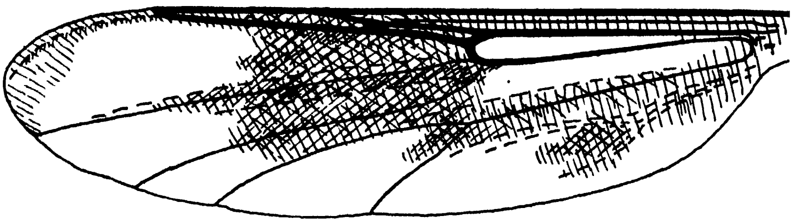


FIG. 20. *Palpomyia pistiae*, sp.n., wing of female to show adornment and venation. × c. 25.

legs in both sexes; the fourth cordiform; and in the female the fifth bearing four or five pairs of rather long, black spines. Claws in both sexes about half the length of the fifth tarsal segment, equal in the female, bearing at the base a fairly large barb, and in the male, bifid at the tips. *Abdomen* very dark brown, venter paler than the dorsum; hairs small and scanty. Spermatheca single, very highly chitinised, oval, length about 125μ, greatest breadth about 110μ; the commencement of the duct chitinised for about 30μ.

HYPOPYGIUM (fig. 21). *Ninth segment* very short: tergite short, with two large lateral processes posteriorly which are partially chitinised and bear numerous long and short hairs; sternite very short, moderately excavated in the middle line posteriorly. *Forceps* set almost at a right angle with the long axis of the body, highly chitinised: side-pieces of the usual form; claspers ending in a stout, black, claw-like process. *Harpes*: basal root-like portion very dark

and highly chitinised; distal portion less highly chitinised, directed posteriorly, and expanded at its end as shown in the figures. *Aedoeagus* large, appearing in a ventral view as an oblong structure with short, black, root-like processes and an apical extension bearing on each side a hook-like process. The ventral surface of the

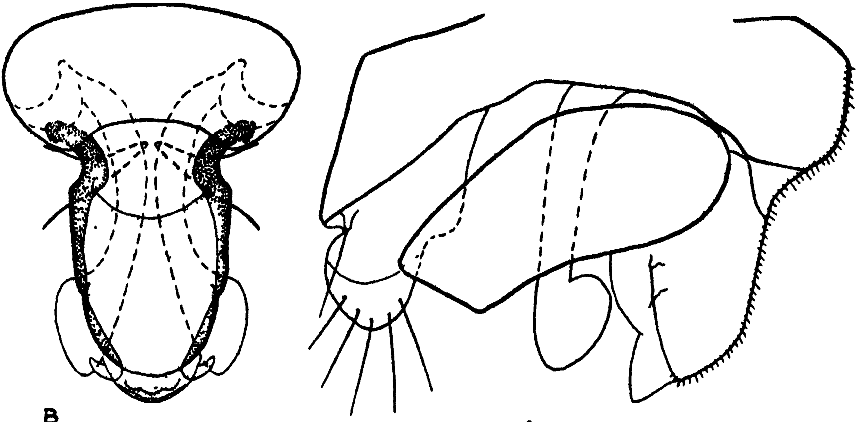


FIG. 21. *Palpomyia pistiae*, sp.n., hypopygium of the male, *A*—lateral view; *B*—ventral view of ninth sternite and median structures only (hairs on ventral surface of aedoeagus not shown). × c. 250.

aedoeagus and the membrane joining it to the ninth sternite covered with minute hairs.

GOLD COAST: Nsawam, a town about twenty-five miles north of Accra, 26th February, 1922; one male and one female, reared from plants of the water-weed *Pistia stratiotes*.

Parabezzia poikiloptera, sp. nov

MEASUREMENTS.	Male.	Female
Length of body (one male and one female) ...	2·1 mm.	2·2 mm.
Length of wing	1·7 mm.	1·7 mm.
Greatest breadth of wing	0·5 mm.	0·6 mm.

Head dark brown; elongated antero-posteriorly, the proboscis directed forwards. Eyes bare; in both sexes separated above by a wedge-shaped space, broadest at the vertex. Clypeus dark brown. Proboscis dark brown; mandibles in the female highly chitinised and strongly serrated, bearing on the inner margin seven stout, triangular teeth. Palpi dark brown, excepting the fifth segment which is

slightly infuscated at the base but is otherwise entirely colourless: first segment very small, about half the length of the fourth, second slightly longer than the fourth, third and fifth longer, sub-equal, nearly one and a half times the length of the second, the third only very feebly inflated in the middle but furnished with a large sensory pit, the fifth somewhat swollen at its end. *Antennae*: in the female, brown, last five segments and the distal thirds of segments three to ten dark brown. First segment darkish brown, rather large, hairless; torus dark yellowish-brown, bearing a few small hairs. Third segment sub-cylindrical, about three times as long as broad; segments four to ten constricted sub-apically, somewhat bottle-shaped, from two and a half to four times as long as broad; segments eleven to fifteen elongated, cylindrical, length increasing progressively from about eight to twelve times the breadth, the last segment being the longest and ending in a blunt process. The combined lengths of segments eleven to fifteen greater than the combined lengths of segments four to ten, namely, about 200 units to 135, or nearly 1·5 to 1. In the male, almost uniformly dark brown (excepting the apices of the thirteenth and fourteenth segments, which are white), and bearing a well developed plume of dark brown hairs. First segment small, hairless; torus large, dark yellowish-brown, bearing a few small hairs; third segment rather large, with a long stalk and bearing two whorls of hairs; segments four to eleven progressively lengthening and narrowing; the twelfth somewhat more produced distally, nearly four times as long as broad; the last three segments elongated, about twelve to fourteen times as long as broad, the fifteenth ending in a blunt process. The combined lengths of segments twelve to fifteen greater than the combined lengths of segments four to eleven, namely, about 195 units to 130, or 1·5 to 1. *Thorax* yellowish-brown mottled with paler, greyish, markings, with dark brown spots at the sockets of the hairs, and with a pale-coloured, median, conical projection anteriorly; sparsely clothed with rather long hairs, which are mostly arranged in five antero-posterior rows, a median, two sub-median, and two sub-lateral. Pleurae rather dark yellowish-brown. Scutellum darkish brown, paler, whitish, posteriorly, especially in the middle line; bearing in both sexes two admedian and two lateral bristles and four small hairs. Post-scutellum dark brown, with greyish anterior

patches. *Wings* (fig. 22) pale, brownish, especially near the anterior margin from the level of the anterior cross-vein to the root of the wing, with numerous small, dark brown markings, mostly restricted to the veins, as shown in the figure. In the male the dark marks are rather smaller than in the female, and the infuscation of the lower ramus of the fifth vein is interrupted in the middle. Venation as shown in the figure. Wing surface covered by microtrichia, but without longer, decumbent hairs. Halteres pale yellowish-brown with dark brown knobs which, however, contain a certain amount of the whitish pigment found also in other parts of the body. There are a few small hairs at the bases of the knobs. *Legs* almost uniformly yellowish-brown, but the distal ends of the tibiae and tarsal segments, and the bases of the first tarsal segments on the

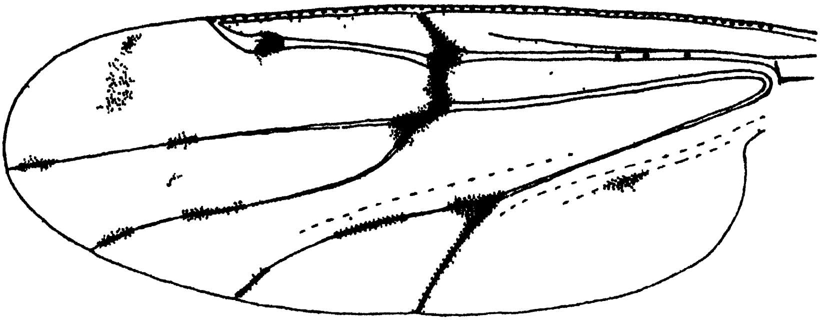
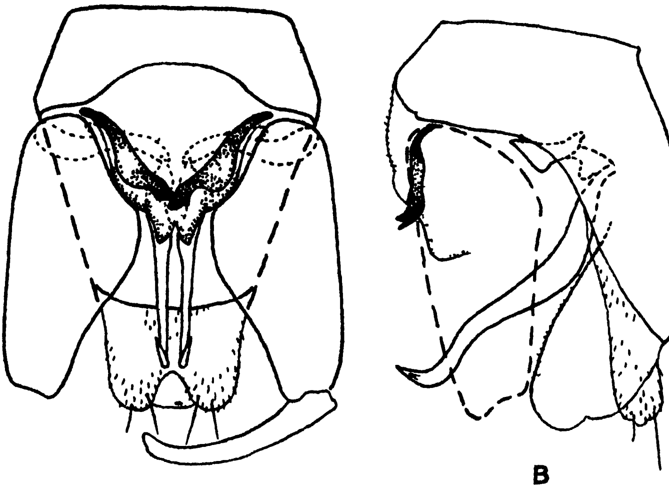


FIG. 22. *Parabezzia poikiloptera*, sp.n., wing of female (fringe not shown) to show adornment and venation. × c. 70.

fore and hind legs are slightly darkened, and small infuscated patches can be distinguished about the middles of the fore and hind femora. Femora not armed with spines and not swollen. Tibiae not armed with spines, but on the hind legs bearing a row of about seven rather long, strong bristles on their apical halves. First tarsal segment at least twice as long as the second on all the legs: on the fore and middle legs armed with a strong basal spine, and similar spines one near the middle of the segment and one (or a pair) near the apex; on the hind legs bearing a strong basal spine and three complete longitudinal rows of small spines. Third tarsal segment on all the legs cylindrical, fourth strongly bilobed, fifth not infuscated and not swollen. Claws in the female, single, nearly as long as the fifth tarsal segment, with a large basal tooth; in the male, two, equal,

small, about half the length of the fifth tarsal segment, with bifid tips. Empodium rudimentary. *Abdomen* almost entirely yellowish- or greenish-white dorsally (the colour being due to a pigment soluble in caustic potash but not in carbolic acid) and brown laterally and ventrally; very sparsely clothed with hairs. Spermathecae two, highly chitinised, oval, sub-equal, and rather small; length 61 μ to 65 μ, greatest breadth about 50 μ, the commencement of the duct chitinised for about 10 μ.

HYPOPYGIUM (fig. 23). *Ninth segment*: tergite rather short but prolonged posteriorly as two large membranous processes, tapering distally, bearing laterally and posteriorly on its dorsal surface a few



B

FIG. 23. *Parabezzia poikiloptera*, sp.n., hypopygium of the male, *A*—ventral view; *B*—lateral view, the aedoeagus slightly shaded. × c. 185.

large hairs, posterior margin rounded, not notched, sternite not very deeply excavated posteriorly. *Forceps* normal in type: side-pieces well developed, tapering distally; claspers rather feebly chitinised. *Harpes* well chitinised: basal portions situated transversely, in part very dark, with a small anterior process on each side; distal portions long, narrow, chitinous bands directed posteriorly and ventrally, tapering distally, and ending in sharp, ventrally-bent, points. *Aedoeagus* with two very strongly chitinised rods, one on each side, directed inwards and backwards, their posterior extremities not fused, but overlapping slightly; these rods have a semicircular

expansion about the middle of their posterior border, and end in a ventrally directed, spine-like process. The membrane joining the aedoeagus to the ninth sternite is spiculated on its anterior three-quarters.

PUPA. Dark brown, highly chitinised; length about 3 mm. to 4 mm. *Respiratory trumpets* (fig. 24 A) peculiarly shaped, with an expanded basal portion, and a long, spine-like, and very dark-coloured distal portion. The main tracheal trunk gives off seven or eight short branches in the expanded portion, and about sixteen to eighteen, arranged in a row along the terminal two-thirds, in the distal portion. *Cephalo-thorax* yellowish-brown, somewhat

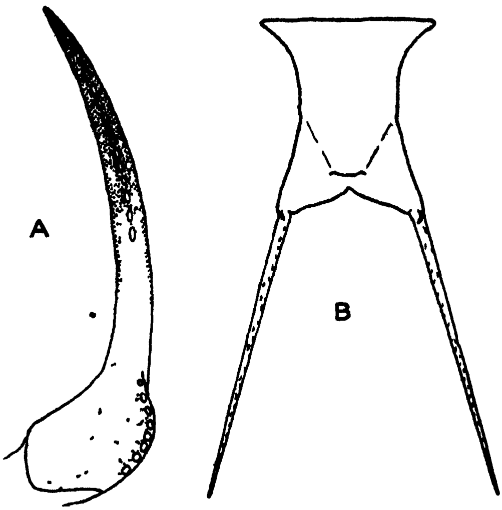


FIG. 24. *Parabezzia poikiloptera*, sp.n. *A*—respiratory trumpet of pupa. × c. 185. *B*—posterior extremity of abdomen of pupa. × c. 90.

infuscated dorsally. Anterior marginal tubercle small, bearing a rather short, stout, bristle; anterior dorsal small, bearing a long hair; anterior dorso-median small, double, each half bearing a small hair; anterior dorso-lateral very large, conical, bearing two long hairs; ventro-lateral ill-defined, bearing a long hair and a socket-like mark; ventro-median obsolete, represented by a small single hair. Dorsal tubercles obsolete, represented by three moderately long hairs. There are on each side of the dorsum also two puckered marks anterior to the situation of the dorsal tubercles, and three socket-like marks more posteriorly. Posterior dorsal tubercle

apparently unarmed. Posterior margin of the dorsum prolonged backwards in the middle line as a conical process. *Abdomen* darker than the cephalo-thorax, infuscated excepting at the bases of the tubercles—which, therefore, by contrast show up as pale elongated areas—reticulated, with small oval or rounded, smooth, pigmented spots arranged as in *Stilobezzia spirogyrae*. First segment short and broad, second longer, third to eighth gradually narrowing, and the ninth small (fig. 24 B), elongated, terminating in two very long lateral spine-like processes which diverge slightly, are spiculated, and bear at their bases two short spines, one dorsal and the other ventral. Tubercles well developed, highly chitinised. Dorsal tubercles: antero-submarginal single, situated anterior to the inter-space between the second and third postero-marginal tubercles, small, bearing a moderately long hair; postero-marginal, five, the inner with two prongs and the others single, the inner bearing a small hair, the second and third apparently unarmed, the fourth and outer bearing small hairs. Ventro-lateral tubercles: antero-submarginal, absent; postero-marginal, three, the ventral small, without a prong, bearing a long, stout, slightly pubescent bristle, the other two larger, with single prongs, the middle bearing a long hair, and the dorsal a short hair. Ventral tubercles: postero-marginal, three, small, the outer two-pronged and bearing a small hair, the other two bearing long hairs.

LARVA. The larva is eel-like and almost white; length about 7 mm. or 8 mm., greatest breadth about 0·4 mm. *Head* yellowish-brown, long, rather narrow; length about 0·38 mm., greatest breadth about 0·17 mm. Eyes black, small, composed of two rounded spots of pigment the posterior of which is the larger, situated a little anterior to the middle of the head. Antennae and palpi relatively large; labrum large and bearing numerous small papillae; mandibles powerful, hook-like. Hairs small, arranged as in *Probezzia pistiae*. Mental plate apparently with four equal teeth at its anterior margin. Hypopharynx not very strongly chitinised, the posterior sclerite comb-like, bearing on each side about seven pointed teeth. *Body* cylindrical, composed of twelve elongated segments each bearing a few small hairs. On the distal end of the anal segment are fourteen stronger hairs, arranged as follows: dorsally and ventrally two pairs of long, stout, black hairs more than half the length of the anal

segment, and laterally a pair of short hairs on each side, with a very small divided hair between them and slightly more anterior. Anal gills of the usual form, rather short.

GOLD COAST: Accra, April and May, 1922; males and females, reared from plants of the water lettuce, *Pistia stratiotes*, taken from a pool near to the station for the Weshiang Railway Line. The larvae frequent the bases of the *Pistia* plants. The adults are phototropic, and in our breeding jars were commonly found resting on the side towards the light and with their tails directed upwards.

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THE PATHOLOGICAL EFFECTS PRODUCED BY *STRONGYLOIDES* IN A CHIMPANZEE

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AND

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PLATE XIII

The animal first came under our observation on 11th January, 1922, at which time it was suffering from dysentery. The faeces were examined on the 11th and 12th January, but no ova or larvae were found. On 5th February the animal had a mild attack of diarrhoea, and numerous rhabditiform larvae of *Strongyloides* were found in the faeces; no blood was passed. After 5th February the animal showed no intestinal symptoms of any kind; it remained under our observation for malaria till its death on 23rd February. On February 23rd, at 8.30 a.m., the animal appeared well and made a good meal. At noon the same day it was found lying in its cage in a condition of collapse and breathing with difficulty; it had vomited a large quantity of bile-stained material; death occurred in half an hour.

POST-MORTEM EXAMINATION

MACROSCOPIC.

The cause of death appeared to be innumerable small recent haemorrhages uniformly distributed over the whole surface of both lungs (Plate XIII, fig. 1). The only other lesion found

in the lungs was emphysema along the inner margins of the lower lobes of both lungs. The vessels on the surface of the brain were dilated. The pericardium contained about an ounce of fluid. The jejunum, from a point about twelve inches below the pylorus, was thickened throughout its whole circumference for a distance of five inches (Plate XIII, figs. 2-4). In this part the gut wall was about 8 mm. thick, as compared with about 3 mm. in the normal part of the jejunum; the mucosa over the whole affected area was friable. At the commencement of this thickened area there was a conical tumour projecting into the lumen of the gut. The base of this tumour was about 3 cm. in diameter, and its apex projected 1·5 cm. into the lumen of the gut. No other lesions were found in the gut.

MICROSCOPIC.

Filariform *Strongyloides* larvae were found in lung smears (Text-fig. 1). Sections of the lung showed emphysema in the

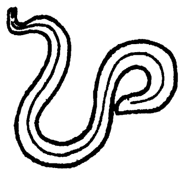

FIG. 1. Filariform larva of *Strongyloides* in the lung.

immediate neighbourhood of the haemorrhages. This emphysema was probably acute following on the haemorrhages and dyspnoea. Filariform *Strongyloides* larvae were found in scrapings of the mucous membrane of the trachea and bronchi. Rhabditiform larvae were present in the trachea, but these were derived from vomited material drawn into the trachea before death. Filariform *Strongyloides* larvae were also discovered in blood from the right ventricle, in the pericardial fluid, in the liver and spleen.

The size of the larvae varied in length from 0·324 mm. to 0·442 mm., and in width from 0·016 mm. to 0·022 mm.

No larvae were found in the brain, and the vascular dilation was probably due to the dyspnoea preceding death.

Examination of sections of the affected part of the jejunum showed thickening due to a large increase in lymphoid tissue in the mucosa, and still more in the sub-mucosa; the muscular layers and serous coat were thickened and showed small-celled infiltration Innumerable adult worms were present, many projecting into the lumen of the intestine, but the majority were buried deep in the mucosa (Text-fig. 2). In many parts the epithelium of

FIG. 2. Adult worm lying above the muscularis mucosae (*m.m.*). × c. 300.

Lieberkühn's crypts was destroyed, apparently through the mechanical agency of the worms. Adult worms were also found in the sub-mucosa (Text-fig. 3) down to the level of the circular muscle coat. Empty worm spaces were seen both in the mucosa and in the sub-mucosa. The worms evidently possess the power of moving through the muscularis mucosae, as some were found projecting through it externally into the sub-mucosa and internally into the

mucosa. In spite of the movement of the worms in the tissue, only very few small haemorrhages were found. Ova with developed embryos were present near the surface and throughout the mucous membrane.

FIG. 3. Parts of adult worms and ova above the muscularis mucosae, and of adult worms beneath the muscularis mucosae (*m.m.*). × c. 300.

The tumour on section was found to consist of a core of muscle tissue. This core was surrounded by a thick layer of lymphoid tissue extending up to the muscularis mucosae. The mucosa and

lymphoid tissue beneath the muscularis mucosae contained numerous adult *Strongyloides*. Adult worms were found adjacent to the muscular core of the tumour; there is, therefore, evidence here that the presence of *Strongyloides* in the sub-mucosa may cause hypertrophy, and even tumour formation.

Adult *Strongyloides* and rhabditiform larvae were found free throughout the whole alimentary tract from the oesophagus down to the rectum. The presence of free adults is attributed to the friable state of the infected part of the gut, those above the lesion being carried up by the severe vomiting which preceded the death of the animal. The size of the adult worms varied from 1·8 mm. to 2·5 mm. by 0·044 to 0·057 mm.

There are several points of interest in the case of this chimpanzee.

(1) During its attack of dysentery, when it was passing blood and mucus, no larvae were found on two successive days.

(2) In spite of a heavy infection, there was no diarrhoea present from 16th January to 5th February, and from 5th February till its death on 23rd February.

(3) The gross lesions in the jejunum were altogether out of proportion to the signs and symptoms, which were slight. It is probable that in some human infections where symptoms are not marked the lesion in the intestine may yet be gross.

(4) The depth at which the worms were found in the intestinal wall seems to preclude the possibility of affecting the worms by the usual helminthicides administered orally. The cures reported by various authors from time to time depend probably on the fact observed in this case that, even with a very heavy infection and considerable damage to the gut, larvae are not always present in detectable numbers in the faeces. Another possible explanation is that those observers were dealing with a slight infection in which the worms were comparatively superficial.

(5) The animal was kept in a wooden box (4 ft. by 3 ft. by $2\frac{1}{2}$ ft.) with a grating on one side placed in the open air. The box was swept and washed out with water daily. The larvae in sufficient numbers to have caused a fatal invasion must have lodged in the crevices of the moist wood.

(6) The invasion must have gone on for several days since larvae were found both in the heart's blood and trachea.

SUMMARY

A chimpanzee which died suddenly was found to have numerous recent haemorrhages in both lungs.

The haemorrhages were found to be due to filariform *Strongyloides* larvae. Larvae were found in the lungs, trachea and bronchi, in the heart's blood, in pericardial fluid, in the liver and spleen.

A heavy infection of *Strongyloides* was found in the jejunum, where a tumour, probably caused through irritation, was present. Adult *Strongyloides* were found at all levels down to the circular muscle layer.

EXPLANATION OF PLATE XIII

Fig. 1. Lung: portion of the inferior surface of the lower right lobe, showing many circular haemorrhages.

Fig. 2. Tumour of the jejunum and part of gut affected by *Strongyloides*. Natural size.

Fig. 3. Normal thickness of the jejunum of the same animal.

Fig. 4. Surface view of part of affected gut with portion of the tumour on left. Slightly enlarged.

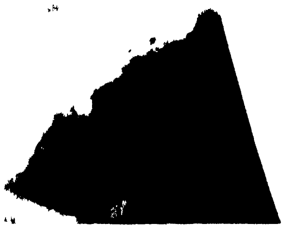

FIG. 1

FIG. 2

FIG 3

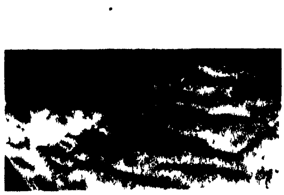

FIG. 4

C. Tinling & Co., Ltd., Imp.

PULMONARY LESIONS IN DOGS AND CATS NATURALLY INFECTED WITH NEMATODES

BY

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AND

S. ADLER

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(*Received for publication* 13 *July*, 1922)

In an examination of a series of thirty domestic animals, twenty-five dogs and five cats, in Freetown, we observed the constant occurrence of pulmonary lesions. These lesions consisted of:—

(1) Small circular haemorrhages from 1 to 5 mm. in diameter, wedge-shaped on section, occurring on any part of the surface of the lungs. Recent and old discoloured haemorrhages were found in all the animals examined, both in adults and young dogs thirteen and fourteen days old. The number of the haemorrhages varied from one to thirty, except in one domestic cat which was brought into the laboratory ill, and which on examination was found to have numerous haemorrhages in the lungs. The cause of the haemorrhages in this animal was obvious, as numbers of ancylostome larvae were found in the bronchi and trachea. In some cases the haemorrhages were situated close together, but were still discrete and never coalesced.

(2) Small scars irregular in their distribution.

(3) Small localised patches of emphysema irregularly distributed over the surface of the lungs, occurring particularly in older animals.

In no case were tubercle bacilli found.

Sections of the haemorrhages showed a variation in the amount of destruction of the interalveolar walls, marked in some and slight in others. The older haemorrhages showed invasion by small

lymphocytes and polymorphonuclear leucocytes, and the presence of fibroblasts. The second type of lesion is probably the result of absorption and fibrosis of old haemorrhages.

All the animals examined were infected with ancylostomes, *A. caninum* or *A. ceylanicum*, or both together, being found. In addition *Toxascaris* and *Belascaris* were found in most of the animals. Although ancylostome larvae were found in the trachea of only five of the thirty animals examined, the haemorrhages in the lungs were, in our opinion, caused by the invasion of nematode larvae. The animals were collected at random from various parts of Freetown, and were apparently average specimens of local animals. The only factors common to all were the presence of nematodes, especially ancylostomes, in the intestine and the lesions in the lungs described, for which no other cause but invasion by nematode larvae could be found. It is noteworthy that in all the animals except the one domestic cat, the number of adult ancylostomes in the intestine exceeded by far the number of haemorrhages in the lungs. It follows, therefore, that the majority of the haemorrhages caused by ancylostome larvae rupturing the capillaries to enter the bronchioles are absorbed without leaving any visible trace, and that the minority are followed by fibrosis, a process which can be followed in sections of some of the haemorrhages.

The small patches of emphysema are due probably to those haemorrhages in which damage to the alveolar walls occurred, and in which fibrosis did not occur along with the absorption of the blood. Owing to difficulties in obtaining post-mortem examinations, we have not been able to ascertain the presence of these lesions in the lungs of human beings. It is obvious that they must occur, since *Ancylostoma* and *Strongyloides* and *Ascaris* must all pass through the lung before reaching their final destination in the intestine. Infection and re-infections with these parasites involving repeated trauma to the lung tissue are common in Freetown and throughout the Tropics. The well-known liability of the native to phthisis has generally been ascribed to lack of acquired immunity, but the constantly recurring trauma to lung tissue by nematode larvae is probably an important accessory factor which will doubtless receive attention from students of tuberculosis in the Tropics.

ANCYLOSTOMES IN ANIMALS IN FREETOWN

BY

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(*Received for publication* 13 *July*, 1922)

Yorke and Blacklock (1915) found that dogs in Freetown were heavily infected with ancylostomes. The species found were *A. caninum* (Ercolin, 1859) and *A. ceylanicum* (Looss, 1911), which were present in the intestines in about equal numbers.

During April, 1922, a number of dogs collected from various parts of Freetown were examined in the Laboratory. It was noted that in ten young dogs, two to three months old, *A. caninum* was constantly present, but no specimens of *A. ceylanicum* were found. An examination of ten adult dogs showed, however, that *A. ceylanicum* was present in eight and *A. caninum* was present in

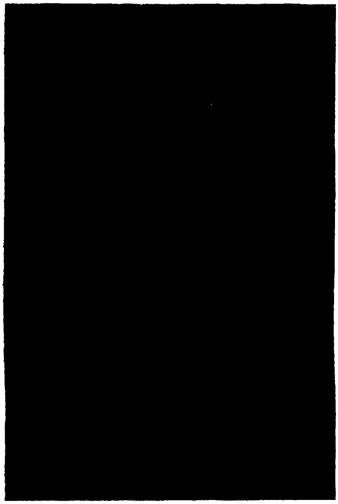

FIG. 1. Two specimens of *Ancylostoma caninum* attached to segments of *Dipylidium caninum*.

every case. It was observed that in dogs *A. ceylanicum* occurs in greatest numbers at a higher level of the intestine than *A. caninum*. In one dog examined a specimen of *A. caninum* was found attached to the mucosa of the large intestine, two inches below the caecum.

Three instances of hyper-parasitism were observed in which

A. caninum was found firmly attached to segments of *Dipylidium caninum* (fig. 1).

Six domestic cats, five adults and one kitten, were examined. *A. ceylanicum* was found in the five adults, and of these, three were also infected with *A. caninum*. In one case, specimens of *A. ceylanicum* were found attached to the mucosa of the pylorus. Of three adult specimens of the civet cat, *Viverra civetta*, one was infected with *A. duodenale* and another with *A. ceylanicum*. One genet was examined, and was found to be infected both with *A. caninum* and *A. duodenale*.

Clayton Lane, in India, found that the size of *A. ceylanicum* varied in different hosts. He gives the following measurements:—

Male 5 mm.	...	Female 7 mm. in the Civet cat
„ 6·8 mm.	...	„ 7 mm. in the cat
„ 7·2 mm.	...	„ 9·8 mm. in the dog
„ 8·5 mm.	...	„ 10·5 mm. in man.

Measurements of *A. ceylanicum*, *A. caninum* and *A. duodenale* in the hosts recorded above gave the following results:—

		Dogs	Cats	Genet	Civet Cat
A. ceylanicum ...	♂	6·0— 8·0 mm.	6·0— 8·5 mm.	...	5·2— 6·2 mm.
	♀	7·0—10·0 mm.	7·0—11·0 mm.	...	6·2— 6·8 mm.
A. caninum ...	♂	6·5— 9·0 mm.	7·0— 8·5 mm.	5·3— 9·2 mm.	...
	♀	7·5—14·0 mm.	8·0—13·0 mm.	5·3—13·4 mm.	...
A. duodenale ...	♂	...	...	5·5— 5·8 mm.	...
	♀	...	...	5·8— 6·8 mm.	8·0—10·0 mm.

All the females included in the measurements were mature.

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THE OCCURRENCE OF ANCYLOSTOMES RESEMBLING *NECATOR AMERICANUS* AMONGST DOMESTIC PIGS IN AMAZONAS

BY

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(*Received for publication* 28 *July*, 1922)

O'Connor (1920) records that when examining domestic pigs from Funafuti (Ellice Islands), he found ancylostomes apparently identical with *A. duodenale* of man. 'The larger females were a little more than 0·8 cms. in length, being thus smaller than the human parasite.'

Maplestone (1921) examined one hundred and eighty-two pigs in the Townsville district, with negative results.

Dr. Maplestone has recently shown me four ancylostomes obtained from a pig at Townsville, some time after his paper of 1921 was published. Three of these appear to be *A. duodenale*, 2 ♂♂, 1 ♀. The other is a female ANCYLOSTOMINAE measuring 0·9 cm., and exactly resembling the species described below.

Legg and Rheuben (1921) found nematodes 'closely resembling *A. duodenale* (man)' in three of a small number of pigs autopsied at Cromarty, about twenty miles from Townsville.

With a view to establishing whether such parasites also occurred in Brazilian pigs, the author carried out a series of fifteen post-mortems on pigs from the town of Manáos in Amazonas.

All the animals were of the domestic variety, and had been kept in, or around, native dwelling-houses. Their ages varied from young 'sucking pigs' to full-grown adults.

The intestines were opened on large flat dishes; all nematodes obtained from the gut, or by subsequent washings of the gut contents, were cleaned by shaking in normal saline, killed with hot

75 per cent. alcohol, and stored in Lacto-phenol. The ancylostomes were then separated and a microscopical examination made of each.

No *A. duodenale* were found, but one hundred and seventy-five ANCYLOSTOMINAE (118 ♀♀, 57 ♂♂), corresponding with *Necator americanus* in all respects, except that of size, were collected from the small intestine of ten of the fifteen pigs examined. The largest number obtained from any one animal was seventy-five, the smallest, one.

Shape and size. All of the one hundred and seventy-five worms examined showed the S-shaped curve characteristic of *Necator americanus.* The length of twenty-eight males varied from 6·5 mm. to 4·5 mm., average 5·1 mm.; and that of sixty-four females from 8·2 mm. to 5·5 mm., average 6·5 mm. The greatest breadth in the males averaged 230μ, and in the females 270μ.

Mouth. The minute anatomy of the mouth was indistinguishable from that of *Necator americanus*, and the average dimensions of the anterior opening of the mouth capsule in fourteen males was 60μ in the dorso-ventral diameter, by 50μ in the lateral, and 68μ by 57μ in the case of thirty-one females.

Bursa. The bursal formula differed in no respect from that of *Necator americanus.* Length of spicules 0·48 mm. (average of 12).

Vulva. This was situated in the anterior half of the body. It is important to note that some of the females were gravid.

SUMMARY

Of fifteen domestic pigs examined for ancylostomes in Amazonas, 75 per cent. showed an infection with what is in all probability *Necator americanus.* Such a high proportion of infection would suggest that the pig, in this locality at any rate, plays a part of some importance in the spread of ancylostomiasis.

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PARASITES IN DOGS AND CATS IN AMAZONAS

BY

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AND

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(*Received for publication* 28 *July*, 1922)

The systematic destruction of stray dogs and cats in Manáos provided us with the opportunity of making post-mortem examinations of fifty dogs and nine cats. Nothing is known of the age of these animals. It was noticed that those in a poor and emaciated condition showed more intestinal parasites than the others. The work was chiefly concerned with ancylostome infection, but other observations were also made as recorded in the tables.

METHOD OF EXAMINATION

The post-mortem examinations were carried out at the local refuse destructor, where the animals were killed by the fumes from burning sulphur. An advantage of this method is that ectoparasites are killed *in situ*. This was always done during the afternoon, and the animals examined immediately afterwards. After searching for ulcers of a possible *Leishmania* character, all fleas, lice, etc., were collected, and films were made from heart blood, lung and spleen. The stomach and intestines were removed and taken to the laboratory, where they were carefully examined along with the washings from the gut contents. A specimen of faeces from the rectum was taken for microscopical examination. Apart from the intestines and heart, nothing of interest was found in the other organs examined.

RESULTS

The results of examination of all the material collected are recorded in the tables below. All the ancylostomes in each animal were not examined, as some animals contained many hundreds, but a sample was taken from each case. The total number examined was nine hundred and thirteen, and comprised:—*A. caninum*, 260 ♂♂, 461 ♀♀; *A. braziliense*, 69 ♂♂, 123 ♀♀. The smallest number found in any animal was one, and the largest number examined fifty-eight. Each worm was identified by microscopical examination.

TABLE I.

Showing the results of examination of Dogs and Cats for Ectoparasites.

	No. of animals examined			
	Dogs 50 (34 ♂♂, 16 ♀♀)		Cats 9 (5 ♂♂, 4 ♀♀)	
	No. of animals harbouring	No. of parasites found	No. of animals harbouring	No. of parasites found
Ctenocephalis canis	11	13	4	7
Trichodectes latus	3	16	0	0
*Heterodoxus longitarsus**	2	2	0	0
Rhipicephalus sanguineus	2	4	0	0

* We are indebted to Miss A. M. Evans for the identification of this parasite.

TABLE II.

Showing the results of examination of Dogs and Cats for Helminths.

	No. of animals examined			
	Dogs 50		Cats 9	
	No. of animals harbouring		No. of animals harbouring	
Ancylostoma caninum, small intestine	49	50	5	5
Ancylostoma caninum, large intestine	22		0	
Ancylostoma braziliense, small intestine	37	37	5	5
Ancylostoma braziliense, large intestine	8		0	
Belascaris marginata	4		0	
Belascaris cati	0		4	
Toxascaris canis	3		0	
Dipylidium caninum	10		0	
*Dirofilaria immitis**	2		0	

* In the right side of the heart. In the case of another dog, a Nematode belonging to the FILARIIDAE, not yet identified, was found in the peritoneal cavity.

TABLE III.

Showing the results of examination of Faeces of Dogs and Cats.

	No. of animals examined	
	Dogs 50	Cats 9
	No. of animals infected	No. of animals infected
Ancylostome ova	49	4
Ascaris ova	2	1
Cestode ova	1	0
Trichuris ova	1	0
Lamblia cysts	3	2
Isospora bigemina	1	5*

* Four of these cats had been kept together.

EXAMINATION OF SMEARS

A nasal ulcer was found in one dog only, the examination of which for *Leishmania* proved negative.

Giemsa-stained smears from lung, spleen and heart blood were examined from each of the fifty dogs and nine cats. Except that some blood films showed eosinophilia, and in the case of one dog a lymphocytosis, the results were negative.

A dog examined some months previous to the fifty here recorded showed microfilaria in the blood, but no adult FILARIIDAE were found.

SUMMARY

It will thus be seen that all the dogs examined were infected with ancylostomes, *A. caninum* being found in 100 per cent. and *A. braziliense* in 74 per cent. Yorke and Blacklock (1915) from the examination of seven dogs, stated that dogs in Freetown were heavily infected with ANCYLOSTOMINAE, *A. caninum* and

A. ceylanicum being present in about equal numbers. Hall (1917) records 'hookworms' in 71 per cent. of seventy-six dogs in Washington, and *A caninum* in 34 per cent. of sixty-seven dogs in Detroit.

Of the nine cats examined by us, 66 per cent. were infected with *A. caninum*, *A. braziliense*, or both.

As recorded elsewhere, *A. braziliense*, although common in dogs in Manáos, does not occur often in human beings, one of us (R.M.G., 1922) finding only four infections in sixty-seven human post-mortems.

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A NOTE ON THE PREVALENCE OF CERATOPOGONINE MIDGES ON THE WINDOWS OF THE ACCRA LABORATORY DURING A COMPLETED YEAR

BY

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AND

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(*Received for publication* 3 *August*, 1922)

With a view to determining the prevailing species of 'sand-flies' in Accra, the collection of small flies from the windows of the laboratory in the evening was begun in October, 1919, and upon finding that they were present in large numbers, was carried on in a systematic manner for twelve consecutive months, namely, from the 1st of December, 1919, to the 30th of November, 1920.

The method of capture of these small insects was that previously described in the first part of our 'Observations on the Ceratopogonine Midges of the Gold Coast' (*Ann. Trop. Med. and Parasitol.*, XIV, p. 189). The windows of the laboratory, which were open all day, were closed each evening at 5 p.m.: shortly afterwards insects began to appear on the insides of the window-panes, and were secured. The period of collection each evening was usually limited to about an hour, 5.30 to 6.30 p.m., owing to the rapid onset of darkness, but occasionally a few specimens were taken later, in bungalows upon walls in the vicinity of a lamp.

A large and varied collection of small insects was obtained in this way. The number of 'sand-flies' taken, that is Ceratopogoninae and *Phlebotomus* spp., was between three and four thousand, and included several new species, the majority of which have already been described. Specimens of *Culicoides*, it may be noted, are easily taken on glass, as they rarely attempt to fly, differing

in this respect from *Phlebotomus* and from the larger species of *Forcipomyia*.

If it be justifiable to draw conclusions from an exceptionally dry year (see Table I), there would appear to be some seasonal variation

TABLE I.

Rainfall and Mean Temperature at Accra during the year.

	Rainfall in inches	Mean temperature
1919 December	...	78·98° F.
1920 January	0·04	80·43
February	0·18	81·34
March	0·74	84·70
April	3·19	84·66
May	2·12	83·33
June	5·07	81·06
July	...	79·40
August	0·17	78·77
September	0·36	75·58
October	1·36	76·01
November	1·79	79·16

in the prevalence of the species of Ceratopogonine midges encountered upon the windows of the Accra laboratory. *Culicoides* were more plentiful than *Forcipomyia* from the beginning of December to the end of May, while from the beginning of June to the end of November they were very scanty. *Forcipomyia*, on the contrary, were rare when *Culicoides* were abundant, and were present in much larger numbers than *Culicoides* in the collections made from the beginning of June to the end of November.

A table (Table II) is given which shows approximately the seasonal prevalence of the more common midges captured. Only those species are included which occurred with tolerable frequency at some part of the year at any rate. In addition, however, single, or but one or two specimens, were taken of the following species:—

*Thysanognathus** (*Prionognathus*) *maculipennis*, C., I. and M., *T. maculithorax*, C., I. and M., *T. pseudomaculipennis*, C., I. and M., *Dasyhelea flavipicta*, I. and M., *Atrichopogon acosmetum*, I. and M., *A. africanum*, I. and M., *A. chrysospherotum*, I. and M., *A. elektrophaeum*, I. and M., *A. kelainosoma*, I. and M., *A. perfuscum*, I. and M., *A. xanthoaspidium*, C., I. and M., and *Forcipomyia* (*hirsuta*). With regard to the names of species of *Forcipomyia* in the table, it is to be noted that in some cases they are only provisional since they refer to new species, descriptions of which have been written but have not yet been published—such names are indicated by being enclosed in brackets. Species of *Phlebotomus* are not included, since they were all forwarded to Prof. R. Newstead.

From time to time flies of large size were taken whilst searching for 'sand-flies,' but as a rule they were avoided since in their death throes they were apt to damage their more delicate neighbours in the killing tube; for the same reason mosquitoes also were looked upon with disfavour. Although, therefore, no systematic collections of such insects were made, the following facts may be noted. Several specimens of *Auchmeromyia luteola*, F., and *Cordylobia anthropophaga*, Grünb., were taken, and one or two specimens of *Stomoxys nigra*, Macq., but no specimen of *Glossina*—a fact which is not surprising considering the rarity of tsetse-flies in Accra and the lateness of the hour at which the collecting was done. The commonest mosquitoes captured were *Stegomyia fasciata*, F., *Culex fatigans*, Wied., *C. decens*, Theo., and *Ochlerotatus irritans*, and it may be recorded that two specimens of *C. rima*, Theo., and a single specimen each of *Stegomyia luteocephala*, Newst., and of *Culex* (*Micraedes*) *inconspicuosus*, Theo., were also taken. These insects presumably were attempting to escape from the laboratory when they were captured.

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* For change of name see *Ante* p. 244.

TABLE II.

The seasonal prevalence of Ceratopogonine Midges on the windows of the Accra Laboratory.

	December, 1919	January, 1920	February	March	April	May	June	July	August	September	October	November
Culicoides accraensis, C. I. & M. ...	xx	x	xx	xx	x	x	...	...	...	...	...	...
C. austeni, C. I. & M.... ...	...	xx	xx	xx	x	x	x	x	xx	x	x	x
C. citroneus, C. I. & M. ...	x	x	x	x	x	...	...	...	...	...	...	x
C. clarkei, C. I. & M. ...	x	xx	x	x	x	x	...	...	...	x	...	x
C. distinctipennis, Aust. ...	x	xxx	x	xxx	...	...	xx	xx	xx	x	x	x
C. grahami, Aust.	x	x	x	x	x	x	...	...	...	...	...	x
C. neavei, Aust.	...	x	...	x	x	...	x	...	...	...	...	...
C. pallidipennis, C. I. & M. ...	x	x	x	x	x	x	x	...	...	...	...	x
C. schultzei, (End.)	xx	xxxx	xx	xxxx	xxxx	xxx	xxx	xxx	xxx	xx	x	x
C. similis, C. I. & M. ...	...	xx	xx	xxx	xx	...	...	...	...	...	...	x
*Thysanognathus** *marmoratus*, C. I. & M.	...	x	x	x	x	x	...	x	...	...	...	...
Centrochynchus [*Lasiohelea*] (*inconspicuosus*)	...	...	...	x	...	...	...	...	x	...	x	...
Forcipomyia castanea, Walk. ...	x	x	x	x	x	xxx	xxx	xxx	xxx	xxx	xx	xx
F. incomptifeminibus, Aust. ...	...	...	...	x	...	...	x	...	...	...	x	x
F. ingrami, Cart.	xx	xxxxx	xxx	xxxxx	xxxx	xxxx	xxx	xxx	xxx	xxx	xxx	xxx
F. inornatipennis, †Aust. ...	...	...	...	...	x	x	x	x	x	x	x	xx
F. (*biannulata*)	x	...	...	...	...	x	x	x	x	x	x	xx
F. (*squamipennis*)	x	x	x	xx	x	xx	xxx	xx	xx	x	x	xx

x = under ten specimens taken; xx = over ten but under twenty, etc.

* For change of name see *Ante* p. 244.

† This name possibly includes two species.

NOTES ON AUSTRALIAN CESTODES

BY

P. A. MAPLESTONE

(*Received for publication* 5 *August*, 1922)

VI. *SCHIZOTAENIA CACATUAE*, sp. nov.

This cestode was found in two individuals of the species *Cacatua galerita*, Lath., the common sulphur-crested white cockatoo. One of these was shot on the mainland near Townsville, North Queensland, and the other on Magnetic Island; but as this island is quite close to the mainland, and birds frequently fly from one to the other, the difference in locality is of no importance.

EXTERNAL ANATOMY.

The length of fixed specimens is up to 200 mm., and the maximum breadth 5 mm. On the whole, the segments are broader than long, but in the anterior immature portion some proglottides longer than broad are found. These longer segments are not regularly placed, and alternate irregularly with ones that are broader than long. When it occurs, the increase in length is not at the expense of breadth, so that the gradual uniform increase in width is not interrupted. Macroscopically, along the median axis of the chain there is frequently a line of depressions, one in each segment; these taken together form a longitudinal groove. This groove is most marked about the central portion of the worm. The posterior angles of the segments scarcely project beyond the edges of the ones immediately succeeding them, and as development is very slow the result is that proglottides are almost rectangular in shape.

Head. The scolex (fig. 1) is almost flat anteriorly, with no rostellum, and has a maximum breadth of 0·240 mm. through the centre of the suckers. The four suckers are placed close to the anterior end, they are flat and circular and do not stand out from the surface; they measure about 100μ in diameter, and look outwards and very slightly forwards.

Segments. Passing posteriorly, the worm becomes gradually narrower and is unsegmented for a distance of 0·8 mm., at which point it is only 0·130 mm. broad.

At first the young proglottides are all broader than long, but when about 0·5 mm. broad many of them may be longer than broad, as detailed above. At this stage the developing reproductive organs can be clearly seen, and it is thus early apparent that the genital pores are unilateral, opening on the right side (fig. 2).

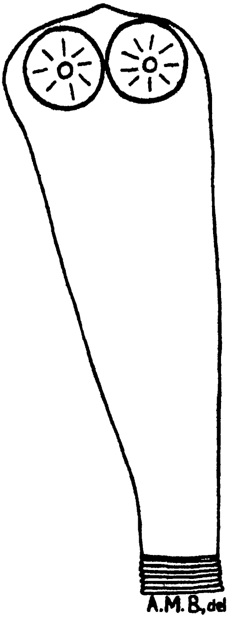

FIG. 1

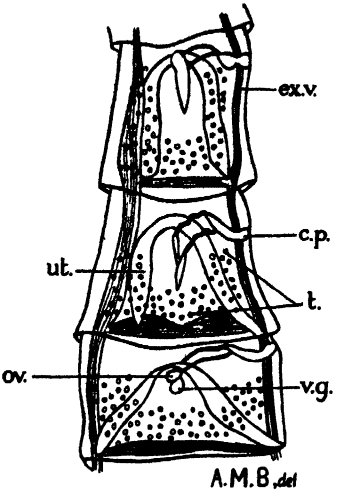

FIG. 2

FIG. 1. *S. cacatuae*. Scolex. × 95.

FIG. 2. *S. cacatuae*. Young proglottides. *c.p.*—cirrus pouch; *ex.v.*—excretory vessels; *ov*—ovary; *t*—testes; *ut*—uterus; *v.g.*—vitelline gland. × 27.

Sexually mature proglottides in fixed and mounted specimens measure about 4 mm. broad and 1 mm. long.

INTERNAL ANATOMY.

Muscular system. The longitudinal muscle is disposed in a single stout layer. Internal to this a thin layer of transverse muscle fibres occurs. Dorso-ventral fibres are fairly well developed.

Nervous system. This was not investigated.

Excretory system. The lateral excretory vessels lie well towards the lateral borders, and pass ventral to the cirrus pouch and vagina. The dorsal vessel lies on the outer side of the ventral, the latter being joined by a transverse commisural vessel, which runs across the posterior of each segment. The vessels present many variations in

different segments. These variations are most easily seen in young proglottides, and the chief departures from the normal are as follows. The ventral vessel may suddenly dilate about the centre of its course through a segment, and the ends remain of normal calibre, thus forming a fusiform sac. Another common variation is a dilatation into a circular cavity at the junction of the ventral and transverse commisural vessels on each side, which dilatation may extend for some distance along the transverse vessel. Also there is occasionally a branch extending inwards and forwards, from the postero-lateral expansion just mentioned, but in no instance could a connexion between the dorsal and transverse vessels be observed.

Genitalia. Development of the sexual organs is slow, and over one hundred proglottides are found, with the sexual organs sufficiently developed to be clearly distinguished before the uterus contains any eggs, and long after this organ has begun to fill the sexual organs remain quite distinct, their atrophy being proportionally as slow as their development.

Testes. The testes are large and very numerous, there being over one hundred in each segment. They occupy practically the whole antero-posterior field of the medulla on each side of the ovary. These two groups of testes are united by a bridge of the same glands passing posterior to the ovary. They lie only very slightly dorsal to this organ. The group on the aporal side is somewhat more numerous than the one on the pore side, and it extends dorsal to, and in some cases overlaps the excretory vessels. The testes in the lateral groups are relatively large oval bodies measuring about 200μ by 0·30μ, but those more centrally placed, which form the post-ovarian bridge, are smaller (about 100μ) and more circular in outline (fig. 3).

Vas deferens. Separate vasa efferentia could not be distinguished, but the vas deferens is seen passing dorsal to the ovary; it runs at first forwards and then it curves laterally to the right running transversely across the right anterior portion of the segment. There is no vesicula seminalis. The cirrus pouch lies dorsal to the excretory vessels and nerve, and on a plane slightly dorsal of the testes. When fully developed it is an elongate sac lying transversely in the right anterior quadrant of the segment measuring about 300μ long by 130μ broad, and having a bluntly rounded mesial extremity.

As a rule, in the mesial portion of the sac a few coils of the vas deferens can be made out. The cirrus, when extruded, measures about 650μ long, and is slightly thicker at the base than the apex, and its outer surface is thickly covered with spines. The atrium is about 160μ deep and 60μ in diameter, and it opens on the external surface near the right anterior corner of the segment, its external opening having thick everted lips.

Ovary. The ovary is practically in the mid line and lies towards the anterior surface of the segment, it is composed of a number of discrete lobes radiating fan-wise. It is slightly asymmetrical, as

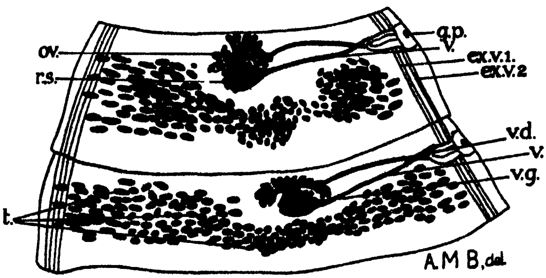

FIG. 3. *S. cacatuae.* Ripe proglottides. *ex.v.*1.—ventral excretory vessel; *ex.v.*2.—dorsal excretory vessel; *g.p.*—genital pore; *ov*—ovary; *r.s.*—receptaculum seminis; *t*—testes; *v*—vagina; *v.d.*—vas deferens; *v.g.*—vitelline gland. × 17.

there are a few more lobes on the aporal than on the pore side. The ducts from the various lobes run centrally, and enter a common duct, behind the centre of the gland. This duct runs posteriorly, and just before it joins the duct from the vitelline glands is surrounded by the shell gland (fig. 3).

Vitelline glands. The vitellarium is of similar structure to the ovary, being composed of a number of discrete lobes, which are united by ducts meeting in a point just in front of its centre. It is more or less divided into right and left halves, the larger of which is on the right side. It lies immediately behind the centre of the ovary.

Receptaculum and vagina. The vagina opens antero-ventral to the cirrus and passes inwards along the anterior border of the cirrus sac, slightly ventral to it. It crosses the vas deferens ventrally and runs parallel to it to enter the receptaculum seminis which lies dorsal to the vitelline and shell glands. The duct from the receptaculum

to the oviduct cannot be made out, as the former organ completely overlies this part of the field.

Uterus. The uterus is visible at a comparatively early stage, and is at first seen as a relatively wide, horse-shoe-shaped tube curving round the ovary anteriorly, and terminating on each side near the postero-lateral angles (fig. 2). When eggs first begin to appear in it, they are situated in the two extremities only, and soon subsidiary pouches

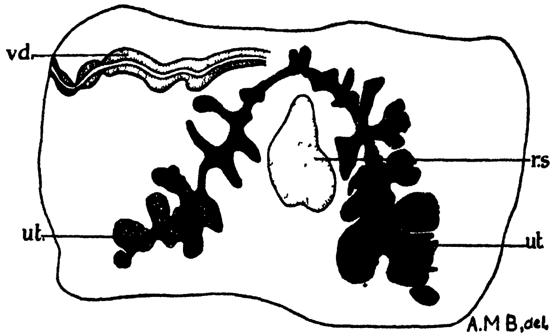

FIG. 4. *S. cacatuae.* Uterus partly developed. *r.s.*—receptaculum seminis; *ut*—uterus; *v.d.*—vas deferens. × 17.

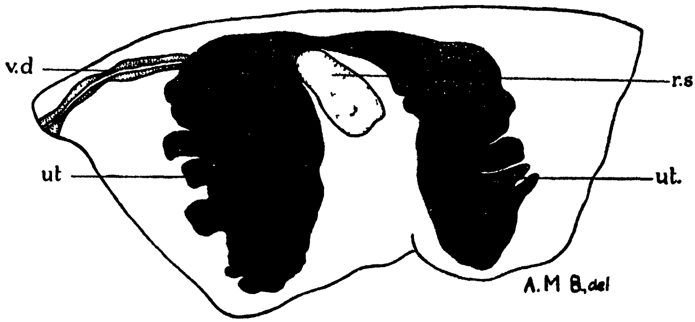

FIG. 5. *S. cacatuae.* Uterus more fully developed. *r.s.*—receptaculum seminis; *ut*—uterus; *v.d.*—vas deferns. × 17.

are thrown out from it both internally and externally, so that its original tubular structure is lost, except in the mesial part in front of the ovary, where the development of subsidiary branches is never marked (figs. 4 and 5). The most advanced stage of development of the uterus which was observed is shown in fig. 5, here the uterus is seen as two large branching sacs occupying practically the whole

of the lateral fields united anteriorly by a narrow tubular portion. The receptaculum seminis persists throughout, and also remains of the vitellarium can be made out for a long time after all other sexual organs have disappeared. These lie in a central position, and the uterus bends round them. The degenerate reticular nature of the uterus described by Douthitt (1915) was not apparent in our specimens.

Eggs. No mature eggs were seen.

DIAGNOSIS.

This species agrees with the genus *Schizotaenia* as described by Ransom (1909), except that the genital pores are unilateral.

As far as the writer is aware, this is the first member of the genus to be described from Australia, and still more important, it is the first *Schizotaenia* to have ever been found in a bird, all those hitherto described being from mammals. But other genera of the sub-family *Anoplocephalinae* have been recorded from avian hosts.

The name *Schizotaenia cacatuae*, after its host *Cacatua galerita*, is suggested.

Type specimens of this cestode are in the Museum of the Liverpool School of Tropical Medicine.

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THE *ASCARIS* OF CATTLE

BY

J. W. S. MACFIE

(*Rceived for publication 8th August*, 1922)

In January, 1921, I received from Major W. P. Beal, Principal Veterinary Officer, Gold Coast, some specimens of *Ascaris*, obtained at Kumasi from a calf, which differed in certain important points from *A. vitulorum* as described by Ransom (1911). In a recent paper entitled 'On *Ascaris vitulorum*, Goeze,' Boulenger (1922) has given an excellent description of the *Ascaris* of cattle based on materials from the Punjab and from Northern Rhodesia, and has pointed out that it fails to agree with the specific diagnosis generally accepted in two most important characters, the worms examined by him possessing cephalic papillae on the lips and post-anal papillae on the tail of the male. As these were also the chief differences noted in the worms collected at Kumasi, I have re-examined my material and have compared it with the description given by Boulenger. The worms were found to be similar in most respects, but certain differences were noted and are briefly described here.

Six males and six females were examined. The length of the males was 10 to 11 cm., and of the females 15·5 to 23 cm. Cuticle with transverse striations, about 60μ to 90μ apart in the middle of the body. Head as described by Boulenger, but smaller, as the worms were smaller. Dentigerous ridges well developed, the teeth about 7μ apart. Oesophagus as described by Boulenger.

Male. Posterior extremity as described by Boulenger. But pre-anal papillae about thirty to forty in a row on each side, the more anterior ones being smaller and more widely spaced than those nearer to the cloaca. Large double post-anal papillae, as described by Boulenger, immediately behind the cloaca. Mucronate appendix with two pairs of papillae on its ventral aspect and two pairs on its dorsal aspect in a similar position, but slightly more lateral, Spicules sub-equal, as shown in fig. 2, and much as described by Boulenger; length about 0·9 mm.

Female. Posterior extremity as described by Boulenger. Tail short, conical; the distance from the anus to the tip of the tail about 0·7 mm. Vulva situated about 25 mm. from the anterior extremity in a worm about 16·5 cm. long. Vagina composed of two portions which merge gradually; the first portion about 12 mm. long, and narrow, diameter about 0·3 mm., and the second about 10 mm. long, broad, and dividing at its distal end so as to form the two uteri.

FIG. 1. *Ascaris* of Cattle. Head, anterior view, ×75. *d.l.*—dorsal lip; *p.*—papilla *d.*—dentigerous ridge.

The uteri run posteriorly, parallel, gradually narrowing and eventually merging with the oviducts. There was no ampulla on the oviducts near their junctions with the uteri. Eggs from the vagina about 0·08 mm. long by 0·06 mm. wide.

The worms, therefore, differ most notably from those described by Boulenger in the number of the papillae on the posterior extremity of the male, and as it is most unlikely that so careful and experienced a worker as Boulenger should have overlooked any of these, it would appear that there are at least two species of *Ascaris* found in cattle in Africa. Further study will be necessary to settle the question whether either of these is identical with the European form.

It may be noted finally that this parasite is the cause of serious disease in the Gold Coast as in Northern Rhodesia. The calf from

which the specimens were obtained died from obstruction of the bowel, and after death, Major Beal found the worms 'in thousands, all intertwined, in the small and large bowels.' The calf was only three weeks old at the time of its death, a fact which is of some interest in view of the possibility of pre-natal infection.

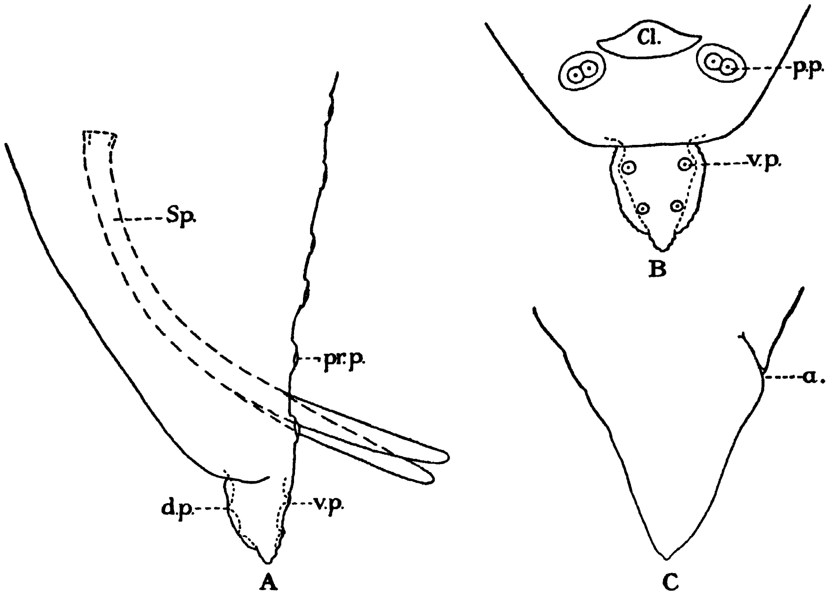

Fig. 2. *Ascaris* of Cattle. (A) Posterior extremity of male, lateral view, ×75. (B) Posterior extremity of male, ventral view, ×95. (C) Posterior extremity of female, lateral view, ×40. *a.*—anus of female; *cl.* cloaca of male; *d.p.* and *v.p.*—dorsal and ventral papillae on appendix; *p.p.*—post-anal papilla; *pr. p.*—pre-anal papilla; *sp.*—spicule of male.

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MOSQUITOES COLLECTED IN THE MANÁOS REGION OF THE AMAZON

BY

R. M. GORDON

AND

A. M. EVANS

(*Received for publication* 11 *August*, 1922)

PLATE XIV

The culicidae recorded below were collected by one of us (R. M. G.) at Manáos Amazonas during 1921 and the beginning of 1922. A few of the species were taken in the town or its outskirts, but the great majority were obtained in the forests surrounding Macapa, a small saw-mill about fifteen miles from Manáos on the Rio Negro.

In this region only a dim light is present in the deeper parts of the forests. Here certain mosquitoes bite freely at all hours of the day, so a good deal of collecting was done by the party walking in single file, each individual 'bottling' mosquitoes as they lit on the person in front. Owing to lack of proper lighting facilities, little or no work could be done at night.

The breeding-places of these forest mosquitoes were difficult to locate, open pools are rare in the forest, and almost devoid of larvae when found. The most common breeding-places encountered were (1) reservoirs of water in natural crevices in the bark of trees; (2) rot-holes in trees; (3) water reservoirs in plants.

The food supply of these mosquitoes is doubtful, their chances of biting man are negligible, and animal and bird life seems extremely scarce.

Particular attention was paid to searching for Anophelines, none were discovered in the forest, the only ones recorded *Anopheles* (*Cellia*) *albimanus* being taken in the town or outskirts of Manáos.

Newstead and Thomas (1910) suggested that it was 'highly probable that other mosquitoes await the discoverer in a region so rich in insect life . . .'; among the present collection are many

species not recorded hitherto, of which four are new and two appear to be well marked varieties of existing species.

Sabethes amazonicus, sp.

FEMALE. *Head.* *Proboscis* long and slender, gradually enlarged apically. *Clypeus* and *tori* black with grey pruinosity. Scales of occiput with deep blue, violet and green reflections above, white beneath.

Prothoracic lobes covered with metallic scales with bright blue and green reflections varying according to the light; a row of coarse black bristles along the margin. *Mesonotum* largely denuded, the scales present similar to those of prothoracic lobes. *Scutellum* with lateral lobes metallic green scaled, mid lobe denuded. *Metanotum* with four coarse black setae. Pleurae and coxae with flat white scales.

Abdomen: Tergite of first segment with bright metallic green scales; white at sides. Scales of rest of tergites metallic with deep blue, pale blue, and green reflections according to the direction in which they are viewed. Sternites white scaled.

Wings with strong reddish-brown infuscation. Scales on knobs of halteres metallic yellowish-green.

Legs long and slender. Hind legs with paddles of long, outstanding scales involving distal half of tibia, metatarsus, and most of second tarsal segment; the longest scales about 1·2 mm. Front legs with tufts of outstanding scales on the distal half of the tibia and a few slightly raised scales at base of metatarsus; longest scales of tufts about 0·5 mm. Hind legs entirely without raised scales. Vestiture dark brown, with bronzy, coppery and violet reflections, femora, tibiae and metatarsi without white. Front tarsi with segments three, four and basal third of five white ventrally, segment four with dark spot at middle; mid tarsi with second, third and basal half of fourth segments white all round, except narrowly at the joints. Hind tarsi with segments three, four and five ventrally white, except narrowly at the joints.

Length: *c.* 7·0 mm. Wing: *c.* 5·5 mm.

Type. One female taken about three hundred yards deep in the forest, Macapa, 22nd December, 1921.

This species evidently comes very near *S. tarsopus*, D. & K., with which it agrees in having tufts of outstanding scales on the front and mid legs only. It differs from that species in the entire absence of white scales on the femora and tibiae and in the details of the tarsal markings.

Sabethoides nitidus, Theob.

Two larvae taken from a rot-hole in a 'Breau' (native name) tree in the forest near Manáos were brought to Liverpool alive. They were kept in an incubator at a temperature from 70° to 80° F., and one of them pupated, the pupa giving rise seven days later to a female *Sabethoides*. Although the specimen differs in certain details of coloration from Theobald's (1901), Howard, Dyar and Knab's (1915), and Dyar's (1919), descriptions of *S. nitidus*, it is referred to this species in the absence of male specimens from this region.

The specimen is more brightly coloured than typical *S. nitidus*, many of the head scales having brilliant pink and mauve tints, the scales of the prothoracic lobes and mesonotum are brilliant peacock-blue, not greenish-blue as in *S. nitidus*. The abdomen (fig. 1), seen

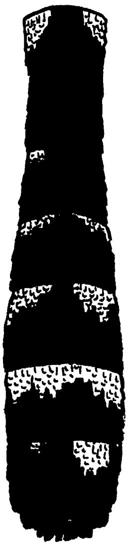

FIG. 1. *Sabethoides nitidus*, Theo., from Manáos region, female abdomen from above. × c. 30.

from above, is coppery with violet reflections, and there are irregular basal patches of brassy scales on segments three and seven; broad, paired, dorsal patches, almost united in the middle, on segments four and five, and on segment six a complete broad, basal band. These brassy scales are quite conspicuous to the naked eye. Lateral basal white spots only present on last segment, not in all segments as in *S. nitidus*. The mid legs are white scaled above on the apical three-quarters of segment two and on segment three, four and five, except the extreme tip of five.

The larva of this species does not appear to have been described hitherto.

LARVA. Stage IV (fig. 2). Head broad. Mental plate with a

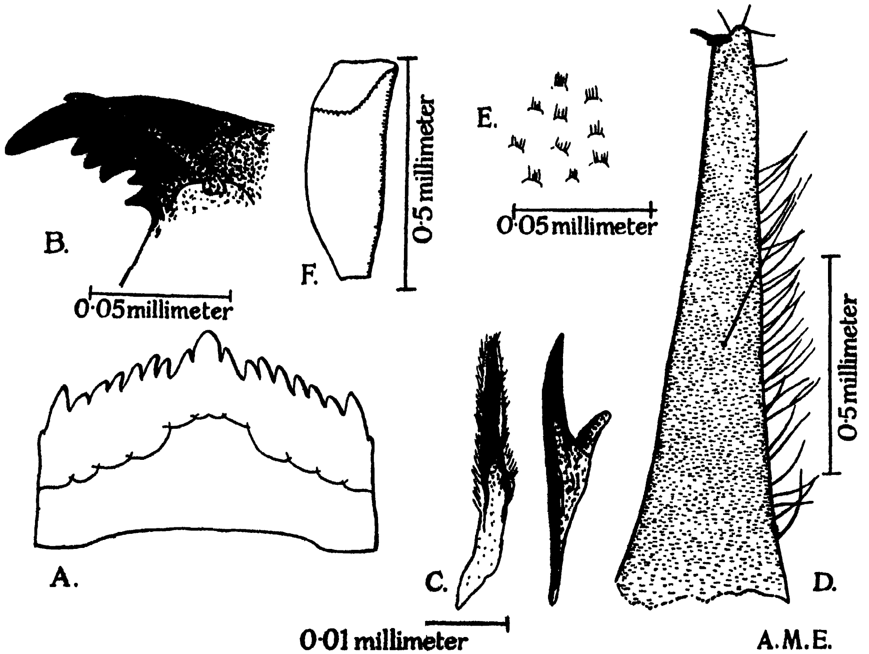

FIG. 2. *Sabethoides nitidus*, Theo., from Manáos region. *A-E*—larva; *F*—pupa. *A*—mental plate; *B*—dentition of mandible; *C*—spines of lateral comb (branched one in lateral view); *D*—siphon tube; *E*—part of surface of siphon tube enlarged; *F*—respiratory trumpet of pupa.

large median tooth and eight smaller ones on each side. Maxillae resembling those of *Sabethinus undosus* as described and figured by Howard, Dyar and Knab (1915), but, left maxilla with five teeth on

inner margin, right maxilla with four teeth in this position. Mandibles similar to *S. undosus*, but dentition (fig. 2 B), *six* (not four) teeth on a process, the terminal one large and falciform. Comb of eighth segment of twenty spines arising from membranous integument, spines thorn-shaped, some with a secondary pointed process (fig. 2 C). Siphon tube three and a third times as long as greatest width, surface with groups of microscopic hairs (fig. 2 E), a row of delicate sub-equal hairs arising from posterior margin for more than two-thirds of its length. Anal segment with plate reaching about half way down segment, dorsal angle on each side with two tufts of two setae; sub-ventrally a tuft of two and a tuft of three setae; lateral angles of plate with a tuft of two setae at each side. Anal gills sub-cylindrical, bluntly rounded, about three-fifths as long as siphon tube. Dorsal hooks of seventh segment, if present, so small as to be undetectable in crumpled pelt.

PUPA. Multiple tufts present on seventh and eighth segments. Respiratory trumpets moderately short and stout, opening wide (fig. 2 F). In life, abdomen with conspicuous dark segmental bands.

The coloration of this metallic scaled species appears to be extremely variable and open to a variety of interpretations. The extent of white on the hind tarsi is also subject to a considerable amount of variation in the descriptions of authors. The dorsal aspect of the abdomen was originally described by Theobald (1901) as 'deep metallic blue with basal coppery bands'; Howard, Dyar and Knab (1915) say 'dorsal vestiture metallic blue and green'; and Dyar (1919), in his coloration table, states that the abdomen has 'irridescent whitish, segmental bands.' A specimen labelled '*S. confusus*' in the British Museum was examined by one of us (A. M. E.), and the coloration of the abdomen above was found to be dark metallic violet with scattered pale scales, and on last segments pale basal bands.

Until a male from this locality is discovered, it must remain undecided whether the range of *S. nitidus* can be considered as extending as far westwards as Manáos, or whether the genus is here represented by a distinct species.

Wyeomyia negrensis, sp. n.

FEMALE. *Metanotum* with flat white scales and a few pale setae intermixed, a tuft of dark setae posteriorly. In other respects,

also, closely resembling *Cleobonnea occulta*, B. W. and B., except that scales on disc of mesonotum *broadly* lanceolate.

MALE. Coloration as in *C. occulta*, but legs differing considerably. Mid legs white ventrally and dark above throughout. Hind legs with femora, tibiae, metatarsi and basal quarter of second tarsal segment white ventrally; rest of tarsi brassy beneath.

HYPOPYGIUM (fig. 3). Side-pieces, tenth sternites and ninth tergites as in *C. occulta*. *Clasper* with a slender, recurved, basal 'lobe' (Dyar, 1919) (1), with retrorse pointed tip, and a wide dilation (*d.*), from which arise three lobes; an outer, rather slender lobe (2), with indications of a row of spines; a long curved lobe (3), with a row of teeth along inner side; an inner broad triangular

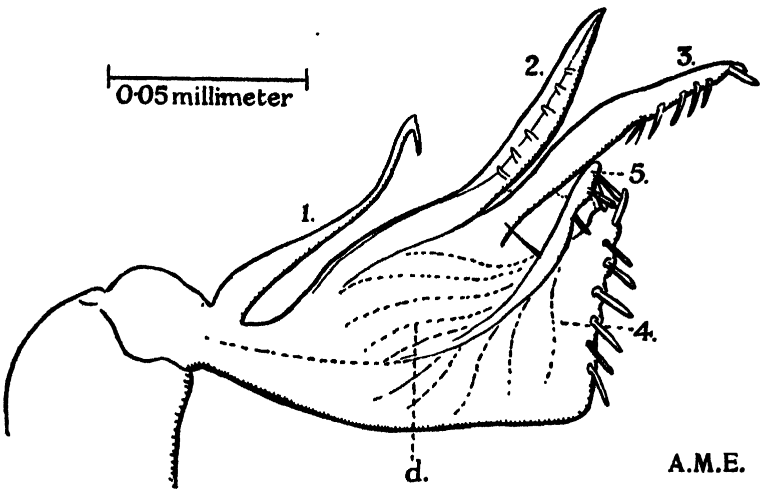

FIG. 3. *Wyeomyia negrensis*, sp.n., male hypopygium, clasper. *d*—dilation; 1, 2, 3, 4, and 5, lobes of clasper.

lobe (4), with coarse teeth along distal edge; and a secondary lobe (5), with teeth on internal surface arising from fourth lobe.

LARVA. Stage IV. Head wider than long, widest at posterior angles. *Mental plate* triangular, with a median tooth and eleven sub-equal teeth on each side. Maxilla with a terminal transparent hook-like tooth, and a row of ten transparent teeth along inner side; a sub-apical tuft of delicate hairs, and near them a single seta on a tubercle, a row of hairs internally, and a short, stout spine near outer margin. *Thorax* with lateral dense tufts. Spines of comb of

eighth segment in a sub-triangular patch. Length of siphon tube about three times its greatest width, false pecten of four spines on distal half, three multiple tufts dorsally and a long multiple tuft ventrally at base. Anal segment with two pairs of dorsal tufts, one of five, one of two hairs; lateral hairs single, sub-ventral tufts of three and two hairs.

PUPA. A tuft of two long hairs bent as shewn in fig. 4 D near

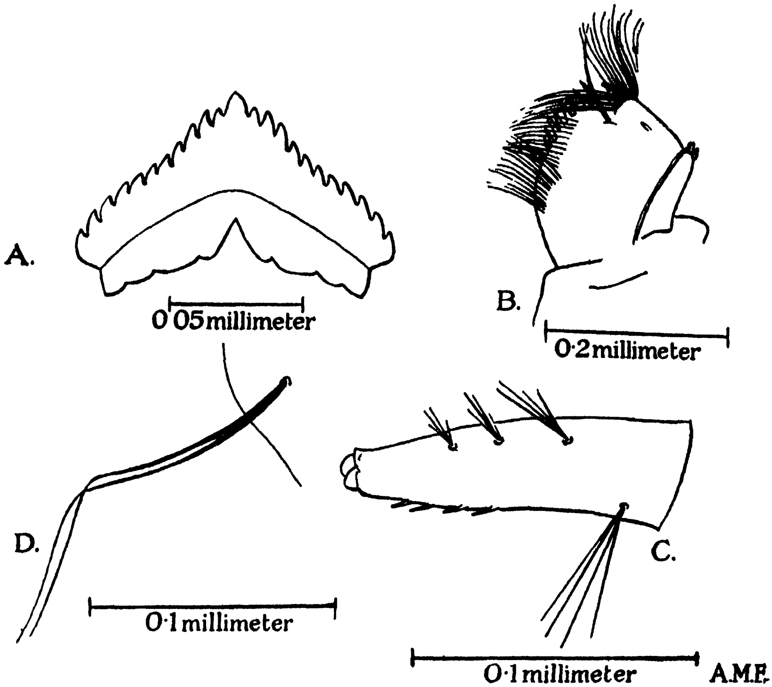

FIG. 4. *Wyeomyia negrensis*, sp.n. *A*, *B*, and *C*—larva; *D*—pupa. *A*—mental plate; *B*—maxilla; *C*—siphon tube; *D*—bent hairs of cephalothorax of pupa.

margin of each eye. A pair of sub-median tufts of eight branched hairs and sub-lateral tufts of four simple hairs behind insertions of antennae. Otherwise resembling pupa of *C. occulta*.

Types. One male and one female, bred from larvae living in the stem of *Bananeira braba* (wild banana) in the forest near Macapa, 20th Decemer, 1921. *Co-types*, five females from the same source.

This species is closely related to *Cleobonnea occulta*, B. W. and B., but there are marked differences in the coloration of the

legs of the male, and in the structure of the clasper. The mid legs of *C. occulta* are described as '*pale*' beneath throughout, and the third, fourth and fifth segments white above. The hind legs are described as white beneath throughout, the last three tarsal segments brassy above. The male hypopygium has the clasper with only three lobes, closely resembling, 1, 3 and 4 of *W. negrensis* according to Dyar's (1919) figure of this structure; the lobes corresponding to 3 and 4 are differentiated much nearer the base than in *W. negrensis*; the dilation (*d.*) is absent. The branch (5) is evidently fused with the inner lobe (4) along its whole length in *C. occulta*. The quadrilobate condition of the clasper excludes *W. negrensis* from Dyar's sub-genus *Cleobonnea*, and it is here placed provisionally in the genus *Wyeomyia*.

Culex (*Neomelanoconion*) *chrysothorax*, Newstead and Thomas.

This species was frequently taken from a pool at the Bosque, about five miles from Manáos (Plate XIV, fig. 3).

Dyar (1918) suggested that it might be synonymous with *C.* (*Choeroporpa*) *chrysonotum*, D. and K.; and Bonne-Wepster and Bonne (1921), examined the types in the British Museum, and came to the conclusion that *C. chrysothorax* is a distinct species differing from *C. chrysonotum* 'by the broad white apices of its femora and tibiae,' and other characters. In view of the fact that most of the specimens in our series have the apices of the femora and tibiae only narrowly and faintly pale, the male hypopygium was examined and compared with that of *C. chrysonotum* described by Dyar (1920). Five specimens were examined; they showed quite distinct differences as follows:—

Inner branch of upper division of lobe of side-piece with larger appendage (fig. 5 A 1), a long, slender filament with recurved pointed tip, not 'somewhat flattened and blade-like' as in *C. chrysonotum*. Halves of mesosome (second plates, Dyar) (fig. 5 B) with a very long horn extending in the same direction as the basal hooks, arising nearer to the apex than the base; not near the base as in *C. chrysonotum*. It should be stated that, owing to the fact that the apical portions of the plates lie in a different plane from the basal main portion and from the horns, a considerable

number of totally different appearances of the whole structure may be obtained by altering the orientation (see fig. 5, C and D). In fig. 5 B the mesosome is drawn as seen when allowed to come to rest

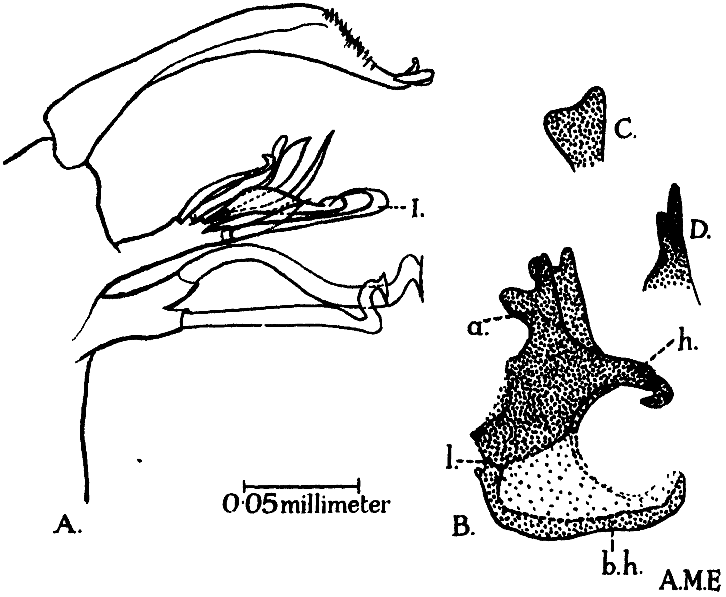

FIG. 5. *Culex chrysothorax*, Newstead and Thomas, male hypopygium. *A*—clasper and lobes of side piece, 1—appendage referred to in text; *B*—entire mesosome, ventro-lateral view; *b.b.*—basal hooks; *l*—line of fracture between basal hooks and halves of mesosome; *b*—horn; *C* and *D*—ventral and lateral views of distal portion of half of mesosome.

on its side; as the two halves diverge at an angle, neither half is seen in true lateral view.

Culex originator, sp. n.

MALE. *Palpi very short, slightly less than one-sixth of proboscis*, slender, pointed. *Proboscis* swollen distally, bent beyond middle. *Occiput* with pale brown, narrow curved scales in middle, and whitish scales at sides and margins of eyes. Upright forked scales numerous, black. *Mesonotum*: integument dark grey, clothed with very narrow, curved, brown scales with slight greenish reflections, and numerous very long, coarse, black setae; two narrow, bare, dorsal stripes extending almost to ante-scutellar space, and a pair of wider, curved, sub-lateral bare lines extending from before wing roots outwards and backwards to lateral lobes of scutellum. Scutellum

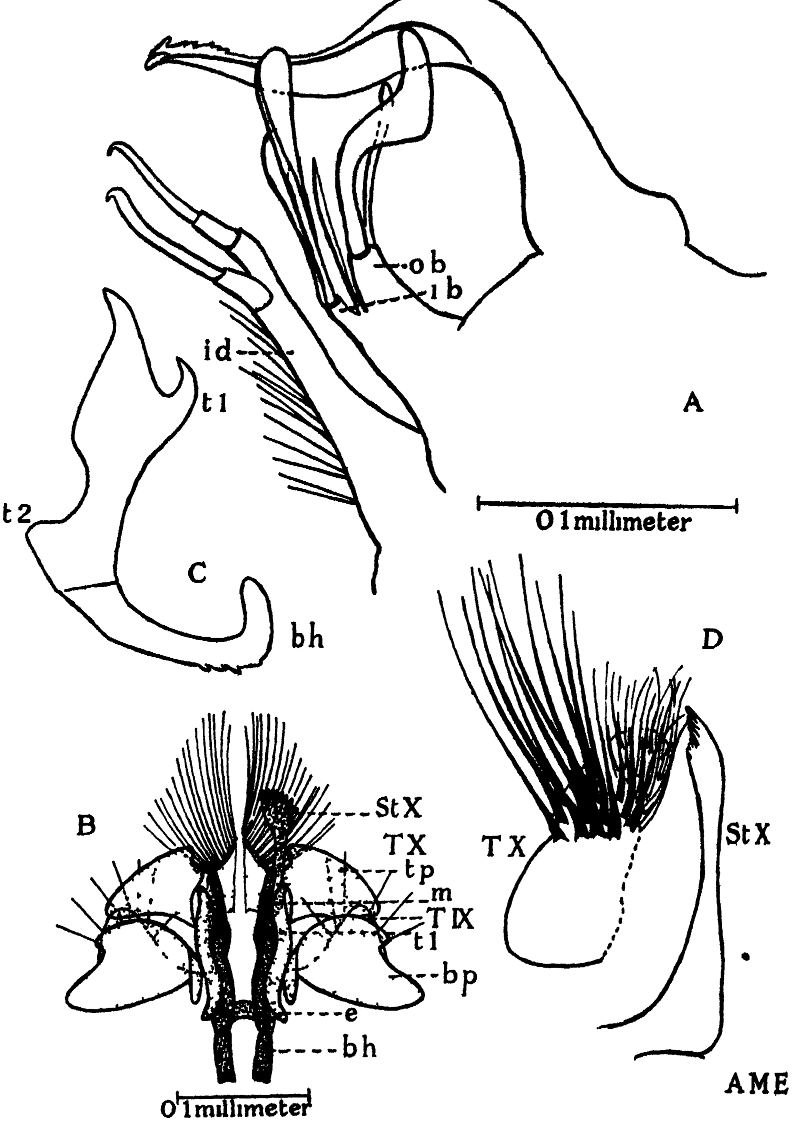

FIG. 6. *Culex originator*, sp.n., male hypopygium. *A*—clasper and lobes of side piece, *i.b.* and *o.b.*—inner and outer branches of outer division, *i d*—inner division, *B*—aedoeagus, dorsi-ventral view, *b.b.*—basal hooks; *b.p.*—basal plate, *m*—half of mesosome, *e*—paramere, *St.X.*—tenth sternite; *T.IX.*—ninth tergite, *T.X*—tenth tergite, *t* 1.—ventral tooth of mesosome; *t.p.*—transparent, triangular plate; *C*—half of mesosome and basal hook, lateral view; *b.b.*—basal hook; *t* 2.—dorsal tooth; *D*—tenth segment, lateral view. *A*, *C*, and *D* to same scale.

unicolorous with mesonotum. Pleurae green, with black setae and some pale ones. Abdomen with dark brown scales above, and on segments seven and eight very pale lateral basal spots. *Legs* clothed with dark brown scales; femora pale beneath; hind tibiae with a line of scales beneath with brilliant yellowish, silvery reflections, except on basal quarter and at distal extremity.

Wings as in *C.* (*Isostomyia*) *conservator*, D. and K.

Length: *c.* 3·5 mm. Wing: *c.* 2·5 mm.

HYPOPYGIUM (fig. 6) *Side-piece* short, rounded, width more than half the length. An area of dense setae near apex on inner side. *Clasper* angularly curved at right angles, gradually narrowing from bend to tip as shown in fig. 6 A. Outer division of lobe of side-piece with distal half divided. Outer branch (*o. b.*) bearing a large filament distally expanded as shown in the figure, and a small spine. Inner branch (*i. b.*) of outer division of lobe of side-piece bearing a stout seta at base, and a pair of expanded filaments distally, one rather more distal than the other. Inner division of lobe of side-piece (*i. d.*) a stout arm, exceeding the outer division, with a row of setae arising from inner side and with two rod-like appendages with curved, pointed tips, the inner situated proximal to the outer. Tenth sternites with slender stem and expanded, comb-shaped apices, with nine teeth. *Apices of tenth tergites with a dense tuft of setae* (fig. 5 D), the longest considerably longer than the tenth tergites. Halves of mesosome (second plate, Dyar), lateral aspect (fig. 5 C) distally pointed, with a strong, pointed tooth on upper (true ventral) edge and a blunt tooth on lower edge near basal hooks; dorso-ventral aspect (fig. 5 B, *m.*), distal portion spatulate. Basal hooks well developed, strongly curved. Ninth tergites (*t. ix.*) rounded, with four setae. 'Transparent triangular plates,' Dyar (*t. p.*), present between basal plates and ninth tergites.

FEMALE. Vestiture similar to the male, but upright forked scales of occiput dark brown; dorsal bare lines of mesonotum partially obliterated on posterior half; faint basal lateral, pale spots on abdominal segments three to six, and apical, lateral, pale spots on segment seven.

Length: *c.* 3·0 mm. Wing: *c.* 2·5 mm.

LARVA. Stage IV (fig. 7). Dorsal head hairs consisting of an inner pair of long tufts (*i. t.*) associated with a single long seta, and

an outer pair of shorter tufts (*o. t.*). Antennae normal, spiny. ***Mental plate*** (fig. 7 B) narrow with a very wide median tooth and eight smaller ones on each side, the last one remote. *Thorax* rounded, wider than long. *Siphon tube* (fig. 7 C) very long, length nearly eleven times the average width. Pecten not reaching beyond basal quarter, three long hairs beyond.

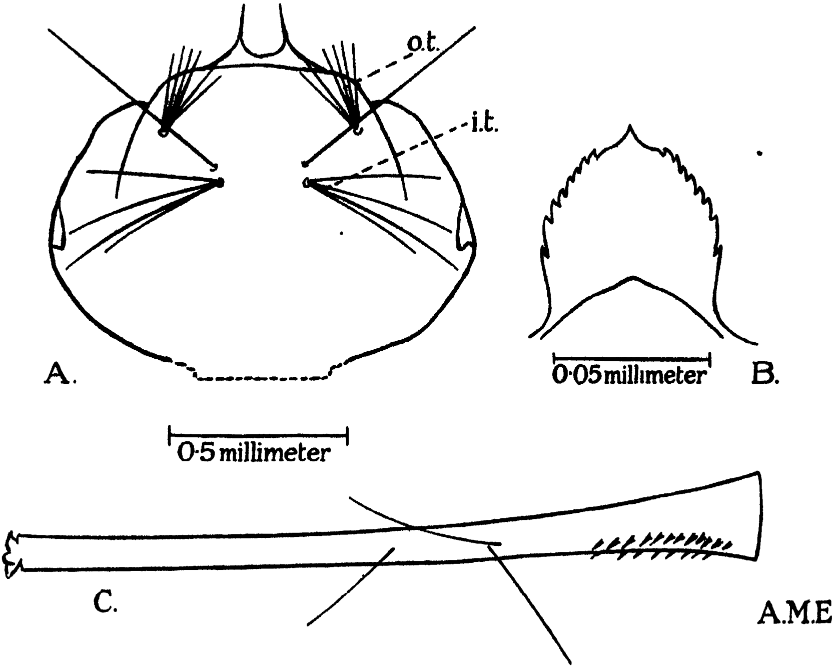

FIG. 7. *Culex originator*, sp.n., larva. *A*—head, dorsal view; *B*—mental plate; *C*—siphon tube.

Type. Male and female bred from larvae obtained from *natural* holes in the bark of the '*Carapana uba*' tree (native name = 'Home of the mosquito') about half a mile in the forest at Macapa, 21st December, 1921, emerged 1st January, 1922 (Plate XIV, fig. 2). *Co-types*, two males and two females from the same source, and one male from larva in rotten tree stump in forest at Macapa.

The characters of the male hypopygium readily separate this species from any other described species of *Culex*, but outwardly it closely resembles *Culex* (*Isostomyia*) *conservator*, D. and K. It differs from this species as described by Howard, Dyar and Knab

(1917) in having a line of brilliant yellowish, silvery scales beneath the hind tibiae, and faint pale segmental lateral abdominal spots. It would appear that the male of *C. conservator* has the upright forked scales of the occiput brown, not black, as in *C. originator*, and that the bare lines on the mesonotum do not extend more than half way back. Dyar (1922) discusses the hypopygial characters of *C. conservator* and the other two species of *Culex* with the male palpi as short as those of the female, *C. isostomyia bifoliata*, Dyar, and *C. micraedes corrigani*, D. and K. From his description of the shape of the clasper in *Isostomyia*, it seems probable that *C. originator* should be put in this sub-genus, although the divided outer division of the lobe of the side-piece, and the presence of conspicuous tufts of spines at the apices of the tenth tergites distinguish it markedly from the other two species. The latter character appears to be unique among American species of *Culex*.

Culex corniger, Theo.

A perfect female was taken in low herbage in a garden in Manáos, 7th June, 1921.

Mansonia coticula, Dyar and Knab.

Two females of this distinctive and beautiful species were caught about one mile deep in the forest at the saw mills, Macapa, 11 a.m. to 3 p.m., 7th December, 1921.

The type specimens were taken in the Panama region, and since its discovery the species does not appear to have been found elsewhere. Our specimens, however, agree with Howard, Dyar and Knab's (1915) description so exactly that we have no hesitation in assigning them to this species.

Females of *Manosnia titillans*, Walker, and *M. amazonensis*, Theo., were frequently taken biting man by day in the forest near Macapa.

Haemagogus (Stegoconops) equinus, Theob.

Three females taken in the forest near the saw mills, Macapa, 11 a.m. to 3 p.m., 7th, 22nd and 23rd November, 1921, are referred to this species.

H. equinus has not hitherto been recorded from the Manáos region, but it has a very wide distribution in South America, Dyar (1921), and in the absence of males the present specimens must be regarded as this species.

Psorophora lutzii, Theo.

In addition to numerous females, a male of this species was caught in the forest near Macapa saw mills, 10 December, 1921.

The male of *P. lutzii* does not appear to have been described hitherto. It differs from the female in having yellow scales immediately in front of the ante-scutellar space, a character which

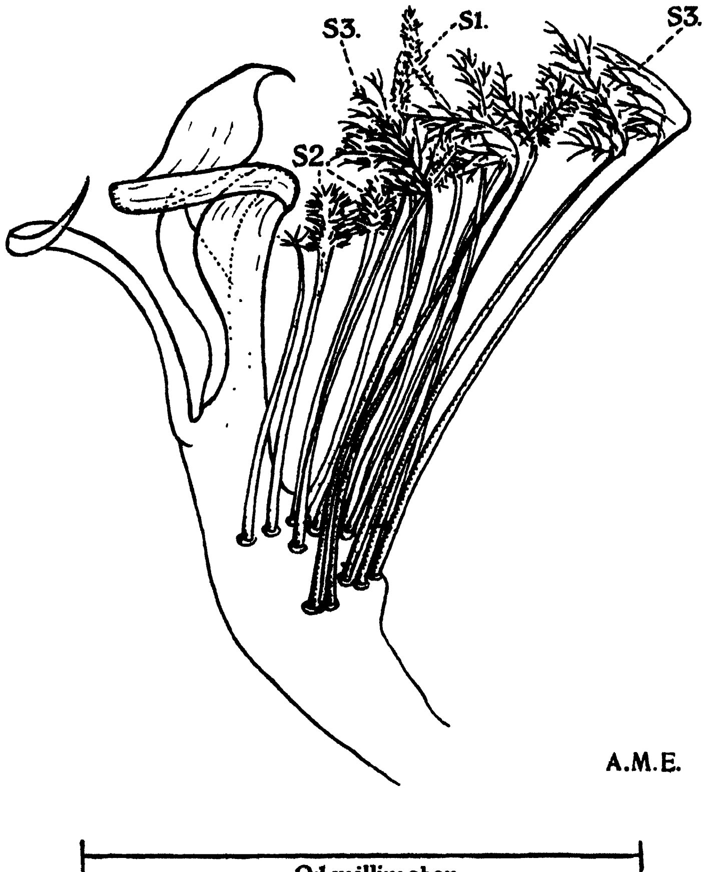

FIG. 8. *Psorophora lutzii*, Theo., male hypopygium, apex of claspette (harpagone); *S.1*, *S.2*, *S.3* types of setae referred to in the text.

was confirmed by Mr. F. W. Edwards, who kindly examined the male specimens in the British Museum collection.

HYPOPYGIUM (fig. 8) with side-pieces, tenth sternites and aedoeagus as in *P. posticatus*. The claspettes (harpagones) H., D.

and K. (1917), apically expanded on inner side; with a large terminal 'S'-shaped leaf, a much smaller curved leaf, and a narrow pointed filament distally curled; internal surface with fourteen (this number may be subject to slight variation) long setae with expanded apices. The setae of three types:—I. (fig. 8, *s*. 1) with apices slightly swollen, bearing short simple hairs; II. (*s*. 2) apices considerably expanded, with longer, very delicate hairs, some of which branched; III. (*s*. 3) apices produced into large membranous expanses, with fine, filamentous, branched processes.

Females of this species and of *P. posticatus*, Wied., were the commonest mosquitoes biting by day in the forest near Macapa.

Aëdes (*Finlaya*) *oswaldi*, Lutz, var. *braziliensis*, n. var.

Two perfect males of the *Finlaya* group of *Aëdes* were referred to this species, although they differed from it in certain respects.

The differences are tabulated below:—

	A. oswaldi	*A. oswaldi* var. *braziliensis*
Mid legs	2nd tarsal segments with basal *third* white	2nd tarsal segment with basal *half* white.
Hind legs	Metatarsus with apical quarter; 2nd tarsal segment with basal third white	Very narrow white rings at these places
Segment VIII of abdomen ...	Dorsally silver scaled	Dorsally dark scaled

The anterior three-fifths of the mesonotum are covered with very thick, bluish silvery, narrow curved scales, the whitish area being deeply incised behind. The hypopygium resembles that of *A. oswaldi*, but the clasper is capitate distally, not pointed as in Howard, Dyar and Knab's (1912) figure of that species.

Type and *co-type* males bred from larvae found in hollow in tree stump, about one and a half miles deep in forest at Macapa, 8th December, 1921.

Megarhinus horei, sp. n.

MALE. *Proboscis* about nine-tenths of the length of the wing, slender, tapering to a point; *palpi* slightly longer than proboscis, vestiture of all but last segment above predominantly peacock-blue, violet towards ends of segment and in front of false articulation; scales at dilated articulations and false articulations white, with pale mauve reflections; all but last segment with pale scales, appearing brassy or whitish according to the direction of the light. Last segment bronzy scaled with deep purple reflections. *Antennae* with hairs of whorls blackish-brown, second segment dotted on distal two-thirds of inner side, with metallic scales appearing peacock-blue, purple or whitish in different lights; tori black with silvery pruinosity. *Clypeus* short, ochraceous brown, darker in centre, with whitish pruinosity. *Occiput* mostly covered with olivaceous green scales, pale blue ones in front and at sides, white scales along ocular margins and beneath. *Prothoracic lobes* with brilliant blue scales above, violet ones towards margin, and white scales beneath, a row of coarse black setae along margin. *Mesonotum*, viewed without magnification from above, bronze, with a median peacock-blue stripe about one-fifth of the width of the mesonotum at the middle, posteriorly the blue area widens and coalesces with blue patches over the roots of the wings; bronze area bordered by whitish blue at edges of disc. Magnified about fifty times with binocular microscope, the bronze area seen to consist of spindle-shaped scales with brassy, coppery, greenish or light blue reflections, according to the direction in which they are viewed; the scales directed outwards on anterior, inwards on posterior half; blue area consisting of broad, flat, backwardly directed scales, bronze when viewed from behind, metallic peacock-blue from above; pale scales bordering disc at sides and in front broader than spindle-shaped scales on disc, very transparent, whitish, with azure-blue and pale greenish-blue reflections. Scales forming patches over roots of wings peacock-blue, with lighter blue and greenish reflections. Scutellum, without magnification bright metallic blue, very slightly paler than blue of mesonotum; with magnification fifty times, scales on mid and lateral lobes similar, appearing peacock-blue with deep violet reflections, pale blue, translucent pale green or translucent brassy, according to

the direction of the light; mid and lateral lobes with groups of stout, black setae. Pleurae and coxae with patches of dense creamy-white scales. Spiracular bristles seven, black; pre-alars seven, pale straw coloured; upper mesepimerals numerous, very pale.

Abdomen above, with segment one metallic pale blue, segments two, three and four with peacock-blue scales, remaining segments and side-pieces bronzy brown, with violet reflections. Sides of segments with apical patches of creamy scales, brilliant blue scales at base, some of scales with whitish and mauve reflections in certain lights.

Scales of venter creamy with silvery reflections, a median dark stripe of bronzy scales with peacock-blue reflections, lateral ciliation short, delicate, pale yellow.

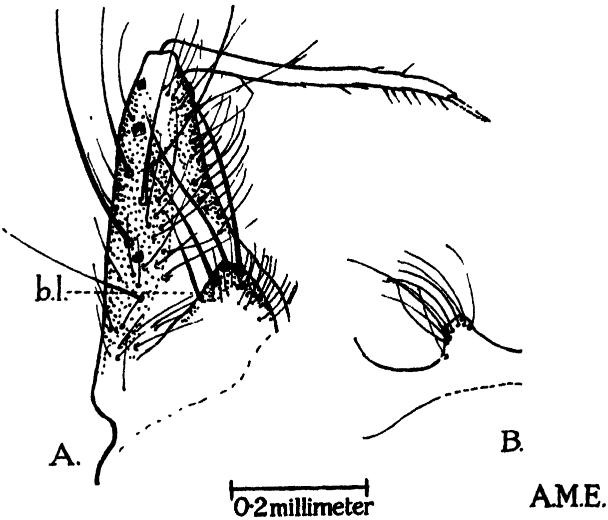

FIG. 9. *Megarbinus borei*, sp.n., male hypopygium. *A*—side piece; *b.l.*—basal lobe; *B*—ninth tergite.

Legs. Vestiture of dark scales with deep blue and purple reflections. Femora brassy beneath, knees entirely dark. Hind tarsi with fourth segment white, except at base and apex, and a very narrow line of dark scales on upper surface behind.

HYPOPYGIUM (fig. 9). Basal lobe of side-piece with three stout setae at apex, of which two very long, reaching almost to insertion of clasper. Ninth tergites short, with about eleven fine setae.

Length: *c.* 10 mm. Wing: 7 mm.

FEMALE. *Palpi*: coloration above similar to male, but scales at articulations dark, with paler violet reflections; brassy scales at sides confined to basal third, rest with reddish-purple reflections.

Mesonotum entirely covered on disc, except on posterior extremity, with dark bronze spindle-shaped scales, which appear deep blue with purple reflections when viewed in a direction parallel to their long axis; posterior portion between wing roots with flat scales of similar coloration. In the normal position the thorax appearing bronzy-brown, except at posterior extremity, and in irregular patches on middle regions of posterior half which appear deep ultramarine blue, owing to the antero-posterior direction of most of the scales in these regions. Laterally the scales directed more or less at right angles to the longitudinal axis, and, therefore, only appearing blue when the thorax is viewed from the side.

Abdomen. Similar to male, but blue colour deep ultramarine, and on last two segments above an almost complete apical fringe of brassy scales.

Legs. Similar to male, but mid legs with segments two and three white on anterior and dorsal surface, except narrowly at apices and bases; hind legs with segment four entirely whitish scaled, segment five with whitish scales on basal two-thirds anteriorly.

LARVA. Stage IV (fig. 10). *Head*, sub-quadrate, about as wide as long, insertions of antennae rather prominent, front margin deeply emarginate, produced into large prominent lobes on each side, bearing mouth brushes. Antennae cylindrical, slender, rather long, smooth, hairs sparse, internally a tuft of two hairs, externally two longer hairs on apical fourth; apex with a jointed and an unjointed appendage and a hair. Dorsal head hairs fine, three on each side behind frontal lobes, behind and internal to antennae a row of three on each side and a minute tuft internally; a single hair internal to eyes and a small branched one apparently rising from eyes. Mouth brushes consisting of nine curved blades. Labial structures (fig. 10, E, F, G) consisting of a broad chitinous fold (sub-mentum ?) hairy in middle distally with internal surface with median area heavily chitinised, tuberculate and a large stout tooth (*m. t.*) arising in centre: a mental plate attached to dorsal surface of fold (see fig. 10 G, which shows relative position of parts of labium), having a very shallow median tooth with a small tooth on each side and

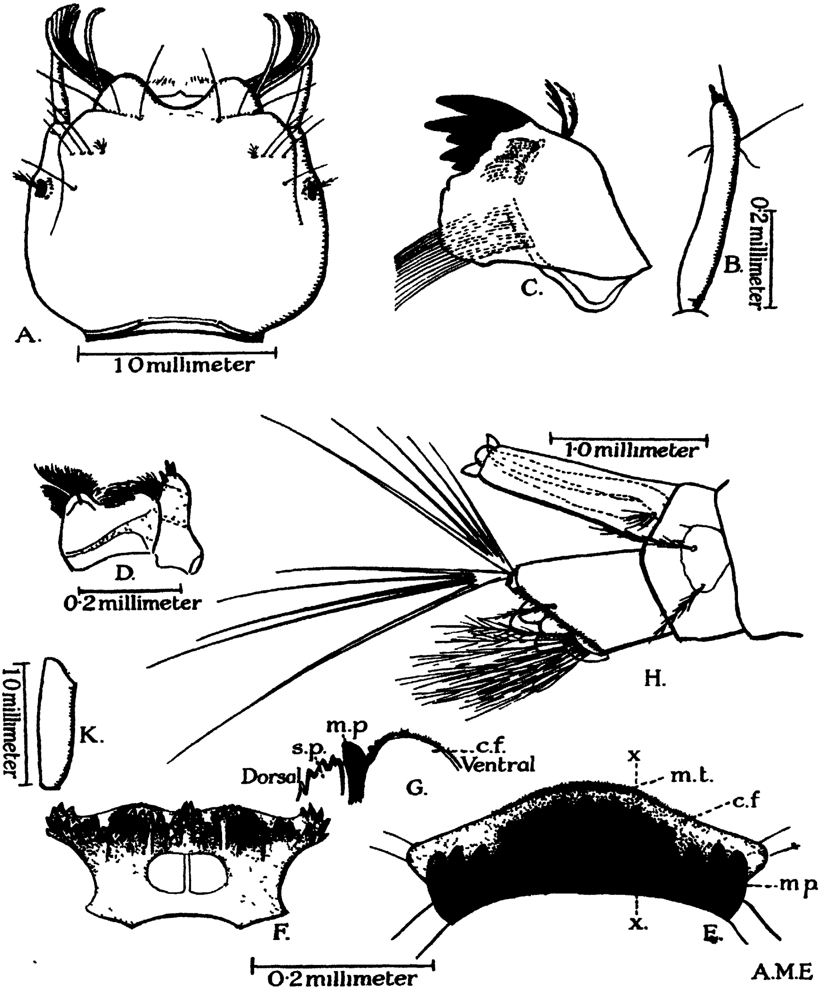

Fig. 10. *Megarhinus borei*, sp.n. *A-H*—larva. *K*—pupa. *A*—head, dorsal view; *B*—antenna; *C*—mandible, to same scale as *D*; *D*—maxilla; *E*—labium, ventral portion; *c.f.*—chitinous fold; *m.p.*—mental plate; *m.t.*—median tooth of chitinous fold; *F*—secondary plate of labium; *G*—sagittal section of labium at *x-x*, *s.p.*—secondary plate; *H*—segments VIII and IX; *K*—respiratory trumpet of pupa.

five large ones beyond on each side; and a "secondary plate" of the form shown in the figure, with the distal portion thickly dentate on dorsal surface, and the teeth tending to form a median, two lateral and intermediate groups. *Mandible* with a pair of sparsely feathered hairs (*h.*) on outer side; dentition of five teeth of which two very large, ensiform; dorsal surface with a row of short fine hairs, and a proximal row of long hairs. *Maxilla* rectangular, bi-lobed distally, edges of lobes densely setose, inner lobe with a stout spine on a prominence behind insertions of hairs; outer lobe with a short, stout sensory spine rising from a tubercle almost at edge, palpi with a chitinous plate as shown in fig. 10 D, and three rudimentary jointed digits. *Thorax* rounded, the stout hairs spinulose. *Abdomen*: lateral tufts of hairs not arising from large chitinous tubercles. Siphon tube about two and a half times as long as wide, no pecten, a single tuft near base. Large plate on side of eighth segment with two stout spinulose hairs on its posterior margin. Anal segment about as long as wide, ringed by the plate; dorsal tufts of two long brushes on each side, a single spinulose lateral hair. Anal gills very short, bud-shaped.

PUPA. Respiratory trumpets as shown in figure.

Length: *c.* 13 mm.

Types. One male and one female, bred from larvae found in stems of *Bananeira braba* (wild banana) in the forest near Macapa, 21st December, 1921. The species is dedicated to Mr. A. T. S. Hore in recognition of valuable services, which he rendered during the collecting expeditions that were undertaken.

BIONOMICS. The larvae of this mosquito were first discovered together with those of *Wyeomyia negrensis*, sp. n., in a stretch of forest about four miles from Macapa. As mosquitoes were extremely plentiful at this point, a small tract of forest was carefully searched for breeding-places, the larvae referred to were found by splitting up the fronds at the base of a '*Bananeira braba*' (wild banana tree). As we were shifting camp the same day, the larvae had to be transported some distance in a hot sun, and none of them survived the journey.

A few days later a wild banana (Plate XIV, fig. 1) was selected growing at the edge of the forest about ten miles from the spot previously examined, this was cut down close to the roots and transported to camp, where it was placed in a petrol tin, the outer

fronds torn off, and finally the base split up with knives. No larvae were found till the base of the tree was reached, those found were lying in the innermost fronds fully six inches from the outer circumference of the tree. The larvae were found to be carnivorous and had to be kept in separate tubes, where they were fed on a diet of *Culex quinquefasciatus* (*fatigans*) larvae and pupae, of which they readily destroyed two a day. In captivity they spent most of their time at the bottom of the jars, only coming to the surface at long intervals.

No eggs were discovered, so the length of larval life is unknown. The average pupation period was found to be six days.

Uranotaenia calosomata var. *albitarsis*, n. var.

The specimens agree with typical *U. calosomata*, D. and K., in the coloration of the head, thorax and abdomen, but the front and mid tarsi have the last three segments creamy-white scaled, not as in *U. calosomata*, in which they are described as having 'a brassy lustre particularly apically.' Hind tibiae with a conspicuous bluish-white stripe extending the whole length behind; in *U. calosomata* the hind tibiae have only the tips narrowly silvery white. Proboscis with a bluish-white line on basal four-fifths beneath, apparently absent in *U. calosomata*.

Hypopygium with spines on basal lobe of side-piece extending beyond the apices of the side-pieces; they are very short in Howard, Dyar and Knab's (1912) figure of the hypopygium of *U. calosomata*.

Type. Male and female bred from larvae taken in old iron bath at the saw mills near Macapa, 20th January, 1922; *co-type*, female from the same source.

Other species of *Uranotaenia* taken were *U. geometrica*, Theo., ♂ 1, flying in low herbage, Manáos, October, 1921; and *U. lowii*, ♀ 1, Manáos, 15th January, 1922.

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EXPLANATION OF PLATE XIV.

Fig. 1. Wild Banana (after having been cut down). Breeding-place of *Megarhinus hoeri*, sp. n. and *Wyeomyia negrensis*, sp. n.

Fig. 2. 'Carapana Uba' Tree. Breeding-place of *Culex originator*, sp. n.

Fig. 3. Breeding-place of *Culex* (*Neomelanoconion*) *chrysothorax* at Boski, Manáos.

FIG. 1

FIG. 2

FIG 3.

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TRYPANOSOMA RHODESIENSE IN A CASE OF SLEEPING SICKNESS FROM THE SUDAN

BY

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DIRECTOR OF THE WELLCOME TROPICAL RESEARCH LABORATORIES, KHARTOUM

(*Received for publication* 25 *September*, 1922)

Three cases of human trypanosomiasis were recently brought to Khartoum by Captain Mackinnon, M.C., R.A.M.C., Medical Officer in Charge of the Sleeping Sickness Camp at Tembura, in the Bahr-el-Ghazal Province of the Sudan.

Gland puncture carried out two months previously had proved positive for trypanosomes in all three cases; in order, however, to minimize the possibility of spreading infection during their journey through fly-infested areas, each patient had received two injections of 0·5 gramme atoxyl.

On arrival in Khartoum gland puncture was again carried out, but trypanosomes could not be found in the several preparations examined; it was decided, however, to inoculate animals with the gland juice obtained from one of the patients. The case selected showed evidence of somnolence with a well marked enlargement of the lymphatic glands of the neck and axilla, as well as a slight degree of pyrexia. An emulsion of the gland juice with a sterile 1 per cent. solution of sodium citrate was prepared, and inoculated subcutaneously into three healthy gerbil rats.

At the end of sixty-six days one of these rats showed an intense infection with trypanosomes in its peripheral blood; stained preparations demonstrated the presence of posterior nucleated forms.

Further details regarding this trypanosome and its pathogenicity for various animals will be published later by Captain Whitehead, M.C., R.A.M.C., Government Bacteriologist; suffice it to say that its morphological characters and pathogenicity for animals, justify

the conclusion that the trypanosome is *T. rhodesiense*, an opinion shared by Professor Warrington Yorke, who kindly examined stained blood films from infected rats, as well as other data submitted.

Investigations regarding the insect carrier of this trypanosome remain to be carried out; it is of interest, however, to note that *Glossina fuscipes* and *G. morsitans* are ubiquitous in the district of Tembura.

The writer is indebted to the Principal Medical Officer, Egyptian Army, for facilities granted in obtaining the material which forms the subject of this brief paper.

AN UNUSUAL TYPE OF NODULAR LEPROSY IN THE SUDAN

BY

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(*Received for publication* 20 *August*, 1922)

PLATE XV

Leprosy has a wide distribution in the Sudan, but is by no means the common entity among the native population as in the countries of the Far East. Of the varieties observed, the nodular or tubercular type is apparently the more common, presenting little difficulty in clinical diagnosis, and occurring usually in the form of well-developed nodular or tubercular lesions of the skin and tissues, as illustrated in a recent paper published by the writer.

The case, which forms the subject of this paper, differed clinically from the usual type of leprosy observed in the Sudan, and appears worthy of record, inasmuch as it presented certain features which certainly obscured the diagnosis.

The patient was an Egyptian, about 30 years of age, who stated he had suffered from an eruption of the skin for a period of one year. According to his history, the eruption apparently commenced on the face in the form of small shotty papules, similar ones eventually appearing on the forehead, ears, trunk and upper and lower extremities. The eruption caused little or no inconvenience, but as it appeared to be getting more extensive and causing some disfigurement, he sought medical advice. His previous medical history contained little of interest. There was no history of syphilis; the patient, however, admitted that his wife had an abortion a few months previously. The case having presented certain clinical features akin to a syphiloderma, and as facilities for proving this by laboratory examination were lacking, he was treated

with a course of injections of '606,' but failed to show any improvement; in fact, his condition became progressively worse.

When seen by the writer, the patient was well nourished and in fair general health. On examination, it was found that the skin of the face, neck, anterior and dorsal aspects of the trunk, and the flexor and extensor aspects of the arms and legs showed numerous miliary papules varying from 0·3 to 0·5 centimetres in diameter. The majority of these were discrete, with a smooth surface, circular contour, pink colour, and of a shotty consistency; some of them showed a slight inflammatory reaction at the base. In certain areas, more especially on the neck and arms, many of the papules showed a circular depression or umbilication in the centre, while others showed simply a pale central area (Plate XV, fig. 1). No pustulation was noted. The largest were on the face, and here the majority of them were discrete, whereas those on the ears had coalesced and caused considerable thickening of the tissues, producing an appearance not unlike that of *haematoma auris*. Papules were also present over both superciliary regions, where a slight degree of madarosis was noted. The skin of the arms was more affected than that of the lower extremities, both flexor and extensor aspects being involved. The intervening portions of the skin presented no abnormalities, except in a few areas on the face where there was a certain degree of erythema.

No nodules or ulcers were detected in the buccal mucous membrane; but the posterior fauces and larynx were slightly inflamed, which accounted for the somewhat hoarse voice of the patient. The submaxillary and axillary lymphatic glands were slightly enlarged and firm on palpation.

No abnormalities were detected in the heart, lungs, liver and spleen. The patient's temperature at the time of examination was normal, but he admitted that he suffered occasionally from attacks of pyrexia.

Two of the shotty papules from the arm were excised, fixed in picric alcohol, and embedded for sections. Microscopical examination of haematoxylin-eosin stained preparations showed the cytological changes associated with a granuloma, and special staining methods demonstrated the presence in the tissues of large numbers of acid-fast bacilli, morphologically resembling leprosy bacilli

(Plate XV, fig. 4). These were especially well seen in sections stained by carbol-fuchsin, decolourized in 10 per cent. sodium sulphite, and finally counterstained with an aqueous solution of methylene blue containing 1 per cent. sodium carbonate.

Histopathology of a nodule

Sections showed a thinning not only of the horny layer of the epidermis, but also of the rete mucosum, the cells of the latter consisting chiefly of oval and columnar cells (Plate XV, figs. 2 and 3). Beneath the lower border of the rete mucosum there was a narrow zone, poor in cellular elements, which stained feebly with tissue stains (fig. 3). Special staining reagents showed it was composed of fibrous tissue, which apparently had undergone a hyaline or vitreous degeneration. Beneath this narrow zone there was a marked cellular reaction in the upper part of the corium. The cells here were composed chiefly of plasma and lymphoidal cells (fig. 2); but no giant cells were present. This cellular infiltration occurred also to a less degree in the pars reticularis, but it varied in intensity in different areas of the nodules. Where well marked, it encroached on the narrow or vitreous zone, extending almost to the rete mucosum (fig. 2). Where it was slight or hardly present the vitreous zone was wider, and beneath it the corium appeared to be composed of loose, oedematous-looking connective tissue in which dilated lymphatic vessels filled with lepra bacilli were noted (fig. 4). This area was rich in lepra bacilli, dense masses extending throughout the *pars reticularis* down to the subcutaneous tissues; they were not found either in the sebaceous glands or in the hair follicles; indeed, these structures, like the blood vessels, appeared to be unaffected. In the vitreous zone, beneath the rete mucosum, only a few single bacilli were found; none were located in the rete or in the horny layer. The infected area appeared to be confined to the corium, the infection reaching that portion of the skin via the lymphatics.

Remarks on the Case

In considering the condition from a clinical aspect, it must be admitted that the case presented certain puzzling features.

The discrete nature of the eruption and the umbilication of some

of the nodules, their size and extensive distribution, together with the clinical history of only twelve months' duration, compelled one to consider and eliminate various skin eruptions that have been studied in this country. Of these may be mentioned Molluscum contagiosum, generalised vaccinia, Lichen hyperkeratosis, cutaneous Leishmaniases, prurigo, yaws and syphiloderma. Most of these could be readily differentiated; the possibility of the case being one of leprosy, occurring, moreover, in a Government official, did not occur to the writer, nor was it suspected by the various medical men who examined the case.

It was left to the histological examination of the excised nodules to throw light on the nature of a condition which might well be termed miliary leprosy.

EXPLANATION OF PLATE XV

Fig. 1. Illustrating the eruption.

Fig. 2. Photo-micrograph of a section of a papule, showing the cellular infiltration encroaching on the rete malpighii. × 190.

Fig. 3. Photo-micrograph of a section of a papule, showing the narrow hyaline zone of degeneration subjacent to the rete malpighii. × 190.

Fig. 4. Photo-micrograph of a section of the corium stained with carbol-fuchsin methylene blue. The dark stained areas represent clumps of lepra bacilli. × 800.

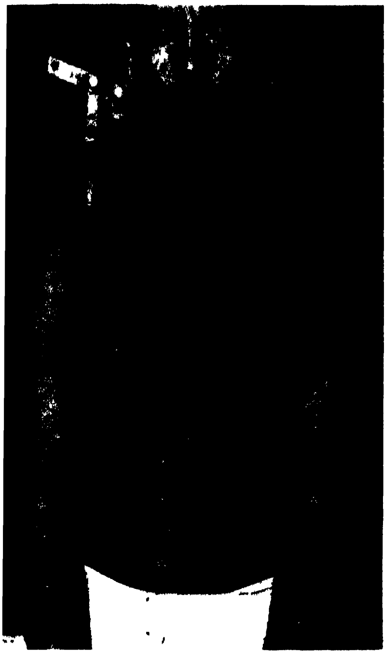

Fig. 1

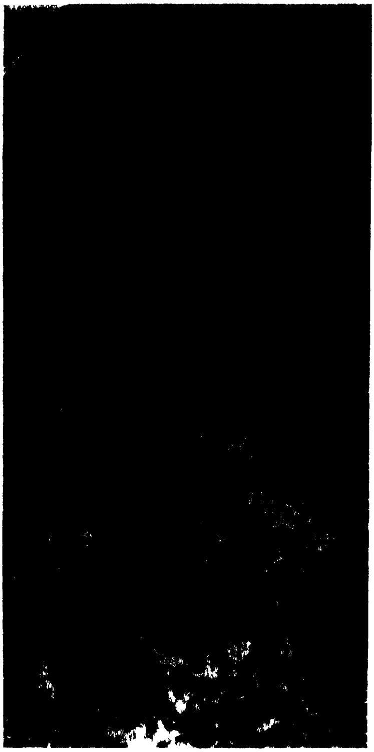

Fig. 2

Fig. 3

Fig. 4

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ANCYLOSTOMA BRAZILIENSE

BY

CLAYTON LANE

(*Received for publication 2 September*, 1922)

In a recent paper, Dr. Gordon (1922) reports finding *Ancylostoma braziliense* in man in four out of sixty-four autopsies performed in Manáos, Amazonas, Brazil, and concludes thus:—'The comparison of these worms and other two-toothed ancylostomes from dogs and cats in North Brazil and India, and also from cats in South Africa and dogs in West Africa, failed to show the difference claimed to exist by de Faria between *A. ceylanicum* and *A. braziliense*.'

It is very desirable that a decision on the matter of identity of these worms should be generally accepted, and the first step necessary seems to be a historical survey rather fuller than that which Gordon supplies.

Gomes de Faria (1910) described *Ancylostoma braziliense* from *Felis domesticus* and *Canis familiaris* in Brazil. Looss (1911) described *Ancylostoma ceylanicum* from the civet cat, *Viverricula malacensis*, in Colombo, Ceylon. Leiper (1913), without examination of *A. braziliense*, suggested, from the appearance of the dorsal ray as figured by de Faria, that the two forms were identical, this ray having, he stated, a pair of digitations only on each of its two branches (Leiper (1915)), a statement which, however, requires alteration (Clayton Lane (1916)). Clayton Lane (1913) first recorded *A. ceylanicum* as a parasite of man, a fact since amply confirmed from various parts of the world, thereby giving to the question of nomenclature a medical interest. De Faria (1914) published a short paper in which he quotes a letter from Looss, who therein states emphatically that *A. braziliense* has only a single tooth on each ventral tooth plate; that its bursal rays, especially the externo-dorsal, are remarkable for their length and delicacy; and that the relative thickness of the bursal rays is a definite differential [specific] character. De Faria (1916), after examining abundant

Brazilian material and comparing it with specimens of *A. ceylanicum* sent by Clayton Lane from Bengal, verifies the existence of the inner pair of teeth, which he describes as much smaller than are those of the Indian forms, but holds, nevertheless, that this comparative examination disposes completely of Leiper's suggestion mentioned above. One of Looss's specific criteria being thus swept away, the specific differences held to obtain between the two forms rested upon the relative slenderness of the bursal rays. In this relation, Gordon published measurements of the externo-dorsal ray of Brazilian forms and of forms supplied to him from Bengal by Clayton Lane. These measurements provided him with no constant differences, nor could he detect other constant distinctions between worms from these two areas or from Africa.

The present intervention is prompted by two motives. The first is that the writer is credited by Gordon with supporting de Faria in his basis of specific differentiation. This is not exactly the case. What he actually did (Clayton Lane (1916)) was to comment upon the complete absence in existing descriptions of measurements of the internal organs; to express disbelief in Looss's statement that only a single pair of teeth existed, it being inconceivable that de Faria should describe and draw a non-existent tooth; to accept Looss's and de Faria's statements that the bursal rays of the Brazilian form were strikingly fine; and to point out that, accepting this as a fact, there emerged the almost certain conclusion that two species were being dealt with. There was this significant addition, 'It will probably be generally felt that there must be a thorough and independent examination by another experienced helminthologist before the question can be considered as settled.' This examination has been made by Gordon, but even his published report leaves certain matters doubtful. The receipt of some material furnished by his courtesy, together with the importance of settling definitely, if possible, the specific name of a parasite of man (the second of the motives to which reference was made above) prompts the present note.

An examination of the appended Table of Measurements mainly dealing with the internal organs of these forms, published apparently for the first time so far as the Brazilian ancylostomes are concerned, affords no justification for the duality of species. On

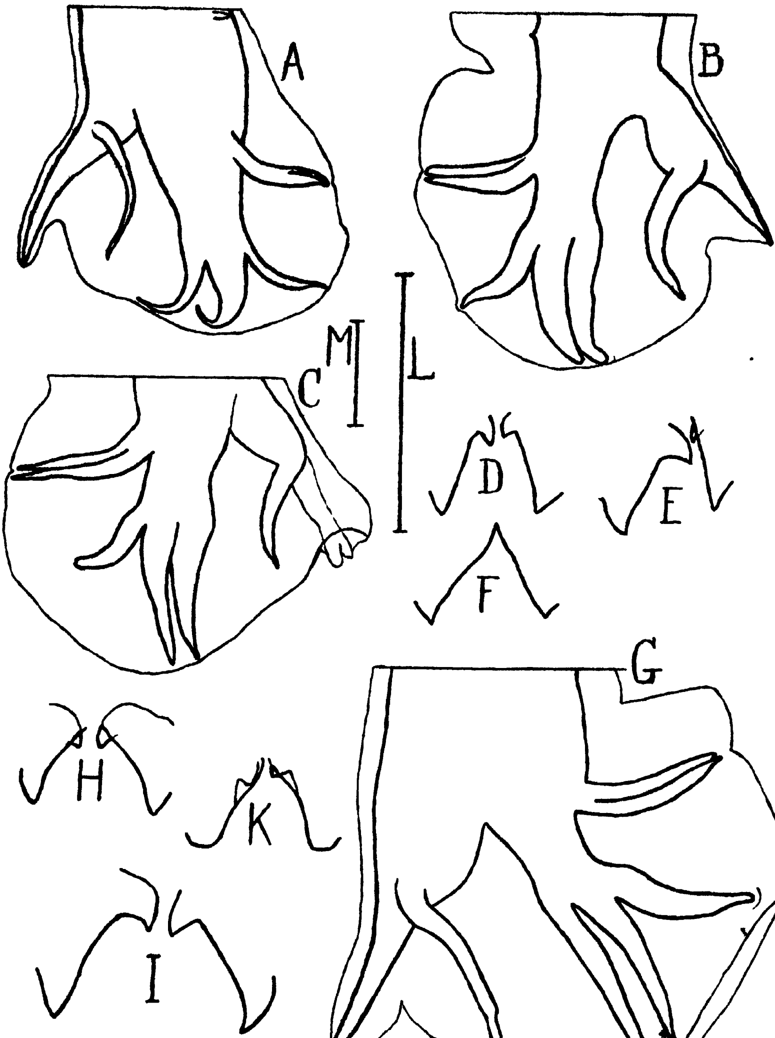

Fig. 1. *Ancylostoma braziliense*

Brazilian forms:
A, *B*, and *C*, the bursae of males.
D, *E*, and *F*, the tooth-plates of males.

Indian forms:
G, the bursa of the male.
H, *I*, and *K*, the tooth-plates; *H* and *K* of males, *I* of a female.

Scales:
L, scale for *D*, *E*, *F*, *H*, *I*, and *K* representing 0·1 mm.
M, scale for *A*, *B*, *C*, and *G*, representing 0·1 mm.

the other hand, it gives no proof of unity of species, as is clear when one considers, for example, the relative measurements of the various members of the genus *Trichostrongylus*. This question must under the circumstances be determined by shape, as, indeed, should always be the case.

Taking first the male bursa: Figs. A, B, and C are from Gordon's Brazilian material; fig. G from the dog in Bengal. Fig. B is typical of the stout-rayed condition generally ascribed to *A. ceylanicum*. In fig. A the rays are much finer. Fig. C shows a condition on the whole intermediate between the other two, although the externo-dorsal ray is short, ending far from the edge of the bursa, while the ventral rays and the internally-terminating lateral ones are pointed. This evidence demonstrates considerable individual variation upon those very points which are held constant within the species. This circumstance led naturally to a re-examination of Indian material. Almost at once the form represented in fig. G was found. Its relatively fine lateral rays are not those associated with the accepted descriptions of *A. ceylanicum*, and yet they are from Indian material.

Turning to the ventral oral plate, figs. D, E and F are from Gordon's Brazilian material. The first shows a direct dorsal view from a male worm, with the inner, deeper teeth fairly marked. Fig. E is that of another male viewed dorso-laterally; the obliquity brings into evidence and increases the apparent size of one deep tooth and obscures and minimises the other. In fig. F, clearing in creosote of this worm, which had lain long in lacto-phenol, was unsatisfactory and the deep teeth were invisible in a direct dorsal view. With lateral tilting their points could just be distinguished. Figs. B and F are from one and the same worm, apparently stout bursal rays being associated with apparent absence of the inner teeth. Figs. H, I and K are from Indian material, fig. I being from a female worm. Fig. K corresponds to fig. F. In it the inner tooth on one side is completely, and on the other almost completely, hidden by the large superficial outer tooth, and, had the specimen been imperfectly cleared, these would have been invisible.

The evidence which has just been given shows that the bursal rays of these two-toothed forms, from whatever part of the world

they come, present great individual differences in length and width, the former partly real, partly apparent, and due to the foreshortening caused by the incurving of the bursal edge; and that marked variations occur in the apparent size of the inner teeth, variations which can indeed, to some extent at least, be produced at will by the rolling of the worm. Both features are largely independent of the country of origin. Indeed, one must conclude that individual prepossession will play a preponderating part in determining whether any particular two-toothed ancylostome of this type is to be classified as *A. braziliense* or *A. ceylanicum*. In other words, there is no evidence offered that acceptable specific differences exist between individuals from the Old and New Worlds. In the absence of such evidence, *Ancylostoma* (*Ceylancylostoma*) *ceylanicum* (Looss (1911)) lapses as a synonym of *Ancylostoma* (*Ceylancylostoma*) *braziliense* (Gomes de Faria, (1910)).

TABLE

Measurements in millimetres of Males of *Ancylostoma braziliense* from Brazil, and *A. ceylanicum* from Bengal.

	Brazilian form	Indian form
Oral cavity, length	0·14	0·143
Oral cavity, transverse diameter	0·08	0·09
Oral cavity, dorso-ventral diameter	0·07	0·087
Nerve collar from head end	0·7	0·57
Cervical papillae "	0·55	0·57
Excretory pore "	0·55	0·57
Width of cuticular striation	0·007	0·0075
Oesophagus, length	0·6	0·7
Oesophagus, breadth	0·1	0·15
Length of spicules	0·8 to 0·9	0·8
Length of accessory piece	0·065	0·075
Length of Cement gland	2·0	3·0

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INTRA-UTERINE INFECTION WITH *ANCYLOSTOMA CANINUM* IN DOGS

BY

S. ADLER

AND

E. J. CLARK

From the Sir Alfred Lewis Jones Research Laboratory, Freetown, Sierra Leone

(*Received for publication* 3 *September,* 1922)

Intra-uterine infection with hookworms has been noted by Howard (1917), who found ova in the stool of a child fourteen days old.

Owing to lack of human material, we examined a number of young animals in order to find whether intra-uterine infection with hookworms is a common occurrence.

Thirteen young dogs (from two to fifteen days old), representing eight different litters, were examined for ancylostomes. The results were as follows:—

Litter	Age in days of dogs	Number examined	*A. caninum*		Remarks
			Worms	Ova	
1	2	2	negative	negative	
2	5	2	negative	negative	
3	5	2	positive (2)	negative	One infection was intense. Ancylostomes up to 7 mm. long with well developed buccal capsules. No ova in the uteri of the worms.
4	7	2	negative	negative	
5	13	1	positive	positive	
6	14	2	positive (2)	positive (2)	
7	14	1	negative	negative	
8	15	1	positive	positive	

It thus appears that in Freetown, where intense infections with *A. caninum* are the rule in dogs, intra-uterine infection is common.

It is noteworthy that, although infection with *A. ceylanicum* is common in adult dogs, we have not found evidence of intra-uterine infection with this parasite.

Infection of the foetus is possible in two ways:—

(1) By larvae passing through the maternal blood stream to the placenta, and through the placenta to the foetus.

(2) By larvae finding their way into the peritoneal cavity of the mother and passing through the uterine muscle to the placenta.

Yoshida (1920) has shown the possibility of this by observing ancylostome larvae in the peritoneal cavity of experimentally infected guinea-pigs; and we have found ancylostome larvae in the peritoneal cavity of a guinea-pig which had been placed for ten hours in a vessel containing a mixed culture of *A. caninum* and *A. ceylanicum*.

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CESTODES FROM INDIAN BIRDS WITH A NOTE ON *LIGULA INTESTINALIS*

BY

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(*Received for publication* 25 *September*, 1922)

A few species of cestodes dealt with below were presented to the author by Lt.-Col. Clayton Lane, I.M.S. The rest of the collection (except *Ligula*) were obtained from animals which died in the Zoological Gardens, Calcutta, on which post mortems were made in the Indian Museum.

The following species are recorded in this paper :—

Parasite	Host
Tetrabothrius erostris	*Sterna bergii*
Davainea tetragona	*Pavo muticus*
,, ,,	*Pavo cristatus*
,, ,,	*Francolinus vulgaris*
Davainea (? *tetragona*)	*Pavo nigropennis*
Davainea microscolecina	*Eclectus vioratus*
,, ,,	*Eos ricinata*
Davainea polychalix	*Lorius garrulus*
Davainea cruciata	*Pica rustica*
Davainea sp.	Crow pheasant
Davainea urogalli	Tragopan pheasant
Davainea tragopani, n.sp.	Tragopan pheasant
Davainea centropi, n.sp.	*Centropus rufipennis*
Cotugnia fastigata	*Ptistis coccineopterus*
Dilepis cypselina	*Dendrocitta leucogaster*
Dilepis campylancristrota	*Herodias garzetta*
,, ,,	*Ardeola grayi*
Choanotaenia decacantha	*Gallinago* sp.
Choanotaenia (? *octocantha*)	Snipe
Choanotaenia microsoma, n.sp.	*Ploceus atrigula*
,, ,,	*Melophus melanicterus*
Cyclorchida omalancristrota	*Platalea* sp.
Rhabdometra tomica	*Francolinus pictus*
Hymenolepis medici	*Pelicanus philippensis*
,, *fusus*	*Larus brunneicephalus*
,, ,,	*Hydropogne caspia*
,, *lanceolata*	*Chenopis atrata*

PARASITE	HOST
Hymenolepis lanceolata	*Cygnus atratus*
,, ,,	Black swan
,, *naja*	*Copschychus saularis*
,, ,,	*Sitta chinensis*
,, *zosteropis*	*Criniger flaveolus*
,, ,,	*Melophus melanicterus*
,, ,,	*Closa* (?) *chinensis*
,, ,,	*Ploceus atrigula*
,, ,,	*Dendrocitta* sp.
Hymenolepis farciminalis	*Pica rustica*
,, *stylosa*	*Brackypternus aurantius*
,, ,,	*Trochalopterum meridionale*
,, ,,	*Pica rustica*
,, *asymetrica*	*Urocissa occipitalis*
,, (? *microcephala*)	*Ciconia alba*
,, (? *simplex*)	*Tadorna cornuta*
,, sp.	*Emberiza luteola*
,, ,,	*Garrulax belangeri*
,, ,,	*Oriolus melanocephalus*
,, ,,	*Liothrix lutia*
,, ,,	*Dendrocitta rufa*
,, ,,	*Tadorna cornuta*
,, *annandalei* n.sp.	*Limosa belgicae*
Echinocotyle uralensis	Snipe
,, ,,	*Gallinago* sp.
Hymenolepis capillaroides	Snipe
Diploposthe laevis	*Netta rufina*
,, ,,	*Nyroca ferina*
,, sp. (? *laevis*)	*Strepsilas interpres*
Dioicocestus novae guineae	*Podiceps albipennis*
Cestode sp.	*Sterna fluviatilus*
Ligula intestinalis	*Danio acquipinnatus*

Family *TETRABOTHRIIDAE*, Ransom, 1909

Tetrabothrius erostris (Loennberg, 1889), Führmann, 1899

Three specimens without heads from intestine of *Sterna bergii.* Lake Tamblegam, Ceylon, 6.9.12. Numbered Z.E.V. $\frac{6047}{7}$ in the collection of the Indian Museum.

Family *DAVAINEIDAE*, Führmann, 1907

Sub-family *DAVAINEINAE*, Braun, 1900

Davainea tetragona (Molin, 1858), R. Blanchard, 1891

♀. About fifty large specimens from intestine of *Pavo muticus.* Zoological Gardens, Calcutta. Collected by the author, 10.12.14.

2. About forty specimens, same host and locality. Collected by the author, 3.1.17.

3 About ninety specimens, same host and locality. Collected by the author, 4.4.18.

4. About twenty specimens, same host and locality. Collected by the author, 12.7.18.

5. Several large and complete specimens from *Pavo cristatus* (common pea-fowl). Zoological Gardens, Calcutta. Collected by the author, 17.4.18.

6. Two specimens without heads from intestine of black shouldered pea-fowl. Zoological Gardens, Calcutta. No date.

7. Several specimens from intestine of *Francolinus vulgaris* (black Francolin). Zoological Gardens, Calcutta. Collected by the author, 30.12.13.

Twelve entire specimens were mounted, and a number of detached heads. In many heads all the hooks had been lost. In others only the hooks on the suckers were missing; in still others some of the rostellar and sucker hooks were missing. Only in two or three heads were the hooks complete. In no case were the pores irregular, being invariably unilateral. Most of the strobilae were old and full of ripe eggs, but quite a number were ripe but not gravid. These measured from 5 mm. to 3 cms. in length.

Davainea (? *tetragona*)

A few fragments without head from intestine of *Pavo nigropennis* (black shouldered peacock). Collected by Lt.-Col. Clayton Lane, I.M.S., Berhampur, Bengal, 15.5.12.

Davainea microscolecina, Führmann, 1908

1. Five specimens from intestine of *Eclectus vioratus* (parrot). Zoological Gardens, Calcutta. Collected by the author, 22.1.14. Previously recorded from *Eclectus rosatus*.

2. Two specimens from intestine of *Eos ricinata*. Zoological Gardens, Calcutta. Collected by the author, 6.7.15.

Some of these specimens shewed a number of ripe segments strongly impregnated with lime. As a result they would not clear in clove oil, but after decalcifying in acid alcohol for several days they cleared readily. This phenomenon was often noted whilst working out the collection of Indian *Cestoda*.

Davainea polychalix, Kotlán, 1920

1. Four specimens from intestine of *Lorius garrulus*. Zoological Gardens, Calcutta. Collected by the author, 15.3.17.

2. Two specimens, same host and locality. Collected by the author, 13.3.17.

Davainea cruciata (Rud. 1819), Führmann, 1908

One specimen from intestine of *Pica rustica* (magpie). Zoological Gardens, Calcutta. No date.

Davainea sp.

A few fragments without heads from intestine of a crow pheasant. Zoological Gardens, Calcutta. Collected by the author, 22.4.15.

Davainea urogalli (Modeer, 1790), R. Blanchard, 1891

One specimen and several fragments from intestine of a Tragopan pheasant. Zoological Gardens, Calcutta. Collected by the author, 27.2.15.

In these specimens the head was about 380μ broad; its length could not be accurately determined because it passed into the neck, but it appeared to be at least 500μ. The suckers have a diameter of about 150μ and are armed with about 17 rows of hooks. The rostellum has a diameter of about 50μ, and is armed with a double row, each hook measuring 7 or 8μ. About 50 were counted, but a number of hooks had clearly been lost. The total number is probably less than 100.

The muscular system is feebly developed and consists of a few scattered longitudinal fibres, internal to which there occur a few transverse strands.

The ventral excretory vessels on each side are very large, having a diameter of about 120μ. They communicate with each other transversely by an equally large tube, in the posterior part of each segment. The dorsal vessel on each side is minute and has a diameter of 10μ only.

The parenchyma throughout the worm is greatly developed, and it is very spongy owing to the occurrence of numerous small excretory cavities.

The pores are unilateral and are situated in the anterior half of the segment. The testes number about 36-40; nine or ten are situated on the pore side and the rest posterior to the ovary, and aporal. Each testis has a diameter of about 55μ when mature. In full development they

extend from the dorsal to the ventral surfaces and from the anterior to the posterior margins. They lie strictly within the water vessels.

The cirrus pouch lies across the antero-lateral angle and extends to the water vessel.

The vagina is posterior to the cirrus pouch. Both the genital canals run between the dorsal and ventral excretory vessels.

Meggitt (1921) states that a number of eggs occur in each capsule, whilst Shipley (1909) states that the eggs lie singly in the parenchyma. In the Indian species the eggs at first occur in numbers in each capsule, but when fully developed each capsule contains only one onchosphere.

Führmann states that the eggs lie within the two ventral water vessels. In our specimens, sections shewed that a single discontinuous layer of eggs was closely adherent to the lateral wall of each vessel, but they did not extend beyond that limit.

DAVAINEA TRAGOPANI, n.sp.

Two specimens from intestine of a Tragopan pheasant. Zoological Gardens, Calcutta. Collected by the author, 27.2.15.

External Anatomy

Only one of the specimens possessed a head. This worm measured 8·5 mm. in length, and its greatest breadth was 600μ. It was composed of 27 or 28 segments; the last segment measured 825μ in length and 600μ in breadth. The second specimen (without head) measured 7 mm. in length and its greatest breadth was 600μ. It contained 27 or 28 segments.

Head. This was 180μ broad and about 125μ long. Without destroying the head it was impossible to obtain accurate details relating to the hooks, but 23 hooks were counted in what appeared to be half the circumference of the rostellum. It seems, therefore, that the total number of hooks present was about 46. They did not appear to be in a double row. Their exact shape could not be made out, but they appeared to be typical. They measured 10μ in length. The suckers are armed, but all the hooks had been lost except in a portion of one sucker, where there appeared to be from 4 to 6 rows.

The neck measured about 300μ in length and was present in both specimens.

INTERNAL ANATOMY

Owing to lack of material the nervous, muscular, and excretory systems were not investigated.

Genitalia. Testes. There are 6 or 7 testes and they first appear in about Segment IV. When fully mature they measure about 70μ. Usually there are four situated aporally, one or two posterior to the ovary, and a single testis on the pore side, posterior to the internal extremity of the cirrus.

Vas deferens. The cirrus pouch when fully developed extends half-way across the segment; in 2 or 3 cases it extends a little more than half-way across. It has very thick (? muscular) walls. In Segment XVII it measures 250μ long and 110μ broad. The cirrus is peculiar in being

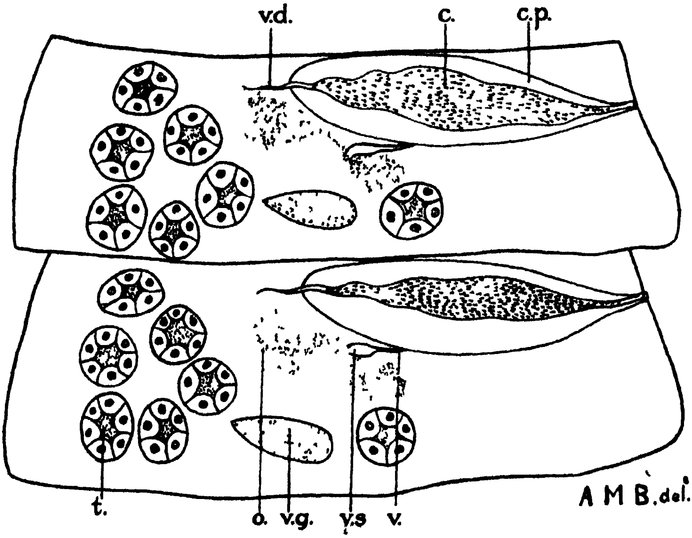

FIG. 1. *Davainea tragopani*, n.sp. Ripe segments, mounted whole, showing genitalia. *c.*—cirrus; *c.p.*—cirrus pouch; *o.*—ovary; *t.*—testes; *v.*—vagina; *v.d.*—vas deferens; *v.g.*—vitelline gland; *v.s.*—receptaculum seminis. × 210.

a greatly dilated organ densely covered with minute spines, and almost filling the cirrus pouch. The cirrus pouch persists to the last segment. The vas deferens is short and very slightly coiled. No seminal vesicle was observed (fig. 1).

The genital pores are unilateral and are situated a little anterior to the middle point of the lateral margin of each segment.

Ovary. The ovary, which first appears in about Segment VIII, is definitely bilobed, each lobe being globular, and composed of a number of rounded acini. In full development each lobe measures about 70μ in diameter.

Receptaculum and vagina. From the pore the vagina pursues a direct course to a point between the two lobes of the ovary where it dilates into a receptaculum seminis.

Vitelline gland. This lies posterior to the ovary and is a conspicuous organ. In full development its transverse and anterior diameters measure about 60μ (fig. 1).

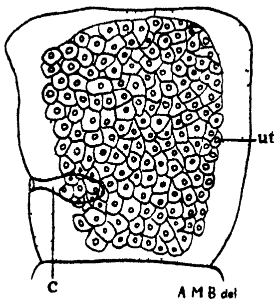

FIG. 2. *Davainea tragopani*, n.sp. Gravid segment, mounted whole, showing uterus. *c.*—cirrus pouch ; *ut.*—uterus. × 50.

Uterus. This first appears as a small cavity immediately anterior to, and between, the two lobes of the ovary. It enlarges and eventually single eggs become isolated in the parenchyma. In the last few segments no trace of the excretory vessels could be seen in either specimen ; it is, therefore, impossible to say definitely whether the eggs extend beyond them or not. But as there was a definite area between the edge of the segment and the eggs, it would appear that the latter lie internal to the excretory vessel (fig. 2).

Eggs. These have a diameter of about 54μ and the onchosphere of about 25μ.

DIAGNOSIS

The species is related to the *proglottina* type. The following table gives details of the various species described which resemble *D. proglottina* in being of small size, and at the same time serves to shew the points in which *D. tragopani* differs from related species. I have, unfortunately,

been unable to procure Kowalewsky's paper. Führmann recently (1919) discussed the relationship of the first four species indicated in the table, and it would appear almost certain that *D. varians*, *D. dubius* and *D. proglottina* var. *dublanensis* are synonyms of *D. proglottina*.

The principal points in which *D. tragopani*, n.sp., differs from them all are :—(1) size ; (2) number of segments ; and (3) the unilateral pores.

The type specimen has been returned to the Indian Museum, Calcutta.

TABLE I.

	Length	Breadth	No. of Segments	No. of Hooks	Size of Hooks	Suckers	Pores	Testes	Eggs
D. proglottina ...	mm. 1·5	mm. 0·5	2-5	80-95	6μ	1 row armed	regularly alternate	22 on one side	35-40μ
D. varians	1·8	?	4-6	44-50	?	4-5 rows armed	regularly alternate	more than 10	?
D. dubius	3·3	0·63	7-9	2 rows 50-60	7·1-8·4μ	4-6 rows armed	alternate	12-15	33μ oncho. 23μ
D. dublanensis ...	4·0	?	6	...	?	armed ?	irregularly alternate	?	?
D tetraoensis	2·3	0·35	9-10	2 rows 120-130	9μ	armed with several rings	a ternate	about 30	oncho. 27μ
D. minuta	1·0	0·4	8	?	9μ	unarmed	alternate	10-12	?
D. paucisegmentata ...	5·0	0·7	5	?	?	unarmed	unilateral	40	16μ
D. bimantopodis ...	1·0	?	7-8	2 rows 50	7μ	armed, no neck	irregularly alternate	4	23μ
D. tragopani, n.sp. ...	8·0	0·6	27	2 rows 46	10μ	4 rows, armed	unilateral	6	54μ oncho. 25μ

DAVAINEA CENTROPI, n.sp.

Three specimens and two fragments from intestine of *Centropus rufipennis* (the common Caccal), Lake Tamblegam, Ceylon, October 1911. Numbered Z.E.V. $\frac{6103}{7}$ in the collection of the Indian Museum.

EXTERNAL ANATOMY

The specimens measured from 2·5 cms. to 3·5 cms. in length and had a maximum breadth of about 1·5 mm.

Head. The head is prominent and presents a truncated appearance; it measured about 300μ broad. Its length could not be determined owing to the fact that it merges into a very short neck. The suckers have a diameter of about 300μ; each sucker bears on its margin about 15 rows of hooks each measuring about 8μ. The rostellum is relatively small and is armed with about 300 hooks measuring from 9μ to 11μ in length and arranged in a double row.

Segments. The segments are very much broader than long, all except a few at the posterior extremity being quite shallow. Their lateral posterior margins are produced as shown in fig. 3. The genital pores are irregularly alternate being situated, and directed, anteriorly.

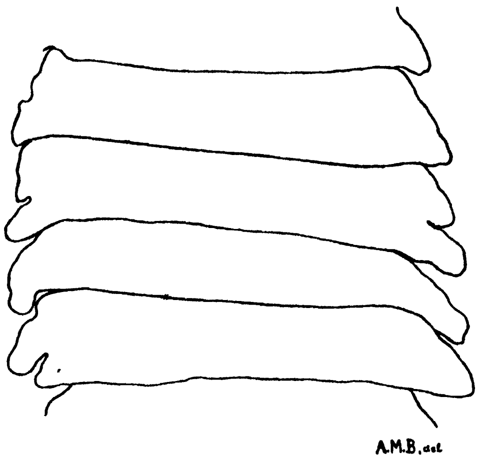

FIG. 3. *Davainea centropi*, n.sp. Outline of four segments. × 35.

INTERNAL ANATOMY

Muscular system. This system is poorly developed; the longitudinal fibres are relatively scanty and consist of small bundles somewhat widely separated; the bundles decrease in size externally. The transverse fibres lie internal to the longitudinal muscles and are also very scanty. No oblique or dorso-ventral fibres were seen (fig. 4).

Nervous system. A small single nerve strand was to be seen lateral to the ventral water vessel on each side. On the pore side the nerve was ventral to the cirrus pouch and vagina.

Excretory system. This consists of a single ventral vessel on each side; on the pore side it lies ventral to the cirrus pouch (fig. 4).

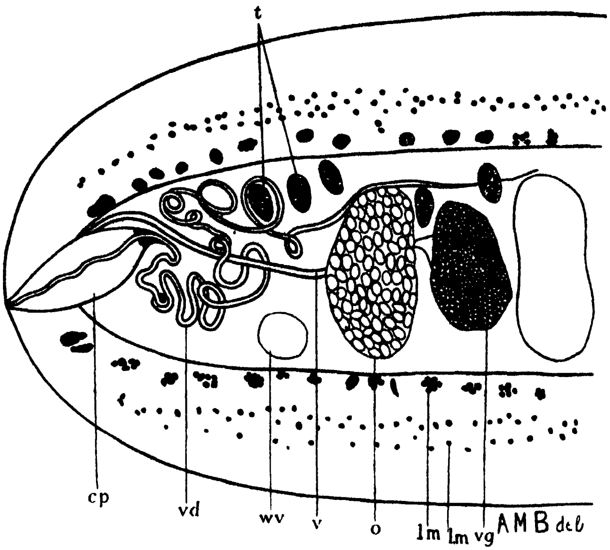

FIG. 4. *Davainea centropi*, n.sp. Transverse section showing cirrus pouch, vas deferens, vagina, ovary and muscular system. *c.p.*—cirrus pouch, *l.m*—longitudinal muscle; *o.*—ovary, *t.*—testes; *v.*—vagina; *v d.*—vas deferens; *v.g.*—vitelline gland; *w v.*—water vessel ×130.

Genitalia. Testes. The testes are about forty in number; they lie dorsal and anterior on each side of the ovary and extend beyond the ventral excretory vessel. They are somewhat oval in shape and, when fully developed, measure about 85μ by 55μ.

Vas deferens. The vas deferens is remarkable in being very long. It extends half-way across the segment and is thrown into a large number of loops which occupy almost the entire field between the internal extremity of the cirrus pouch and the poral wing of the ovary. No seminal vesicle was observed. The cirrus pouch varies in length, extending from about half to three-quarters the distance between the lateral margin and the ventral excretory vessel (fig. 4).

Ovary. The ovary is a relatively large bi-lobed organ lying ventral

and posterior; in full development it extends almost to the dorsal transverse muscle fibres (figs. 4 and 5).

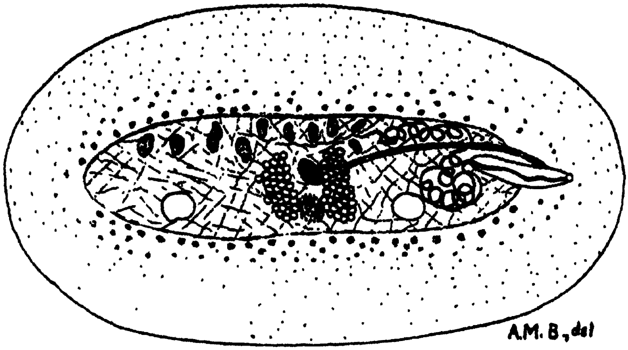

FIG. 5. *Davainea centropi*, n.sp. Transverse section showing male and female genitalia. × 70.

Receptaculum and vagina. From the pore, the vagina runs dorsal to the cirrus pouch; at the internal extremity of the latter organ, the vagina curves gradually and runs directly to the ovary. It is muscular throughout its length. Its internal extremity is dilated into a muscular receptaculum seminis, which, in full development, measures about 150μ in length and 50μ in breadth (fig. 4). The oviduct, vitelline duct, and fertilisation canal are noticeable on account of their length.

Vitelline gland. This lies ventral to and between the two lobes of the ovary; it is large and easily seen (figs. 4 and 5).

Uterus. In full development, the uterus extends beyond the ventral excretory vessels and consists of a large number of parenchymatous capsules, each containing a single onchosphere.

Eggs. These have a diameter of about 55μ; the onchosphere measures about 36μ.

DIAGNOSIS

Up to the present only about fourteen species of *Davainea* have been recorded which have armed suckers, and irregularly alternating genital pores. The species just described differs very definitely from them all. I therefore consider the species new and have named it *D. centropi.*

Cotugnia fastigata, Meggitt, 1920

Three specimens from intestine of *Ptistes coccineopterus*, Gould, 1865. Zoological Gardens, Calcutta. Collected by the author, 13.11.15.

The specimens had the following measurements :—

TABLE II

	1	2	3
Length	75·0 mm.	70·0 mm.	60·0 mm.
Greatest breadth	3·5 mm.	3·8 mm.	3·3 mm.
Number of segments	212	210	205

As Meggitt was unable to isolate and figure a complete rostellar hook, a drawing of a hook from the Indian example is given below (fig. 6).

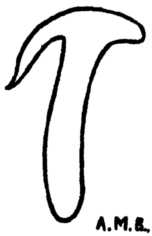

FIG. 6. *Cotugnia fastigata*, Meggitt. Diagram of a hook.

In our specimens the vagina was almost invariably situated some distance posterior to the cirrus pouch, and as a result it was impossible to determine whether the vagina was dorsal or ventral to the pouch. In 6 or 7 segments examined, however, the vagina was definitely dorsal to the pouch on one side and ventral on the other—a character peculiar to the genus *Moniezia*.

Family *HYMENOLEPIDIDAE*, Railliet and Henry, 1909

Sub-family *DIPYLIDIINAE*, Stiles, 1896

Dilepis cypselina, Neslobinsky, 1911

One fragment with a head, of what is almost certainly this species, was obtained from the intestine of *Dendrocitta leucogaster* (tree-pie) ; Zoological Gardens, Calcutta. Collected by the author, 7.12.15.

The head was armed with a double crown of about 90 hooks, measuring about 24μ. The genital pores were unilateral. The cirrus pouch was situated anteriorly, and extended almost to the water vessel.

Dilepis campylancristrota (Wedl, 1855), Führmann, 1908

1. Four specimens from intestine of *Herodias garzetta* (paddy bird), Berhampore, Bengal. Collected by Lt.-Col. Clayton Lane, I.M.S., June, 1912. Numbered Z.E.V. $\frac{6019}{7}$ in the collection of the Indian Museum.

2. Numerous specimens from *Ardeola grayi* (pond heron), Zoological Gardens, Calcutta. Collected by the author, 14.12.13, and numbered Z.E.V. $\frac{6161}{7}$ in the collection of the Indian Museum.

Choanotaenia decacantha, Führmann, 1913

Four specimens from intestine of a snipe (*Gallinago* sp.), Berhampur, Bengal. Collected by Lt.-Col. Clayton Lane, I.M.S., 17.12.12.

The specimens agreed with Führmann's description except in the following minor details :—

(1.) The hooks measured $23{\cdot}4\mu$; in the type specimen they measured $19{\cdot}8\mu$ to $21{\cdot}6\mu$.

(2.) The type specimen had from 40 to 50 segments ; the Indian forms have from 40 to 98 segments.

Choanotaenia (? *octocantha*, Führmann)

1. One specimen, without head, from intestine of a snipe, Berhampur, Bengal. Collected by Lt.-Col. Clayton Lane, I.M.S., 12.3.12.

2. One specimen from same host and locality. Collected by Lt.-Col. Clayton Lane, I.M.S. (219 b), 17.12.12.

CHOANOTAENIA MICROSOMA, n.sp.

1. Six specimens from intestine of *Ploceus atrigula* (the eastern baya). Zoological Gardens, Calcutta. Collected by the author, 26 10.15.

2. About twelve specimens from intestine of *Melophus melanicterus* (the crested bunting). Zoological Gardens, Calcutta. Collected by the author, 25.6.15

External Anatomy

The worms measure from 4 mm. to 8 mm. in length and have a maximum breadth of about 630μ. They consist of from 25 to about 50 segments.

Head. The head is square and measures about 220μ; the suckers have a diameter of about 140μ. The rostellum measures about 180μ in length and has a diameter of about 50μ. Its anterior extremity is expanded and has a breadth of about 90μ and a length of 40μ. It is armed with a single row of from 16 to 20 hooks which measure about 35μ (fig. 7).

There is no neck.

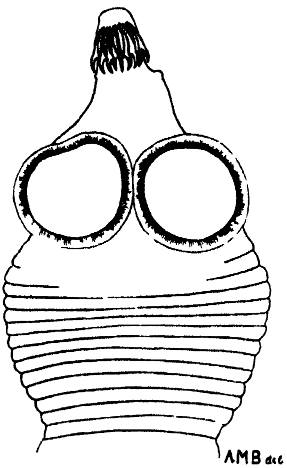

FIG. 7. *Choanotaenia microsoma*, n.sp. Head and anterior segments. × 170

Internal Anatomy

Muscular, excretory and nervous systems. As the material was not sufficiently well preserved details of these systems are not obtainable.

Genitalia. Testes. There are from 16 to 20 testes situated posterior to the ovary. When fully mature they have a diameter of about 36μ (fig. 8).

Vas deferens. The genital pore is situated at the extreme anterior lateral angle of the segment and is very large and prominent. The cirrus pouch is short and narrow, extending to the water vessel to which it is dorsal. It lies anterior to the vagina. The cirrus is remarkable in

having its extreme tip armed with short spines set at right angles to its length. Immediately median to the tip, the cirrus is armed with a number of hooks of a different shape which measure 30μ in length, and which lie

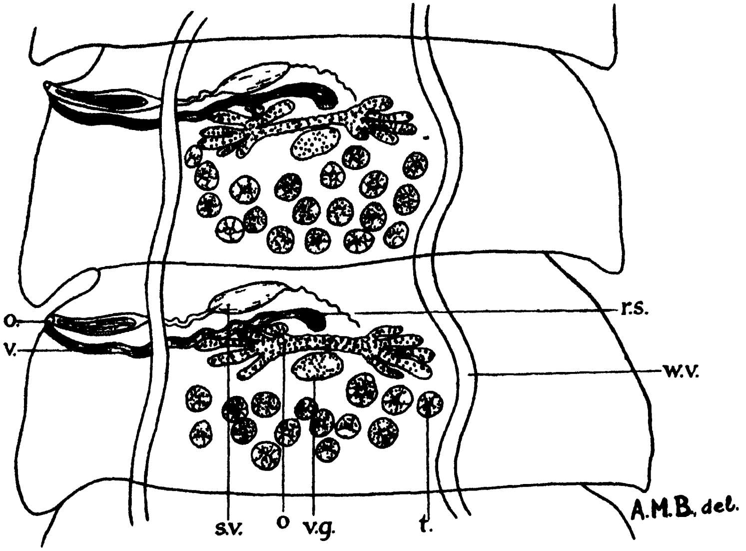

FIG. 8. *Choanotaenia microsoma*, n.sp. Horizontal section showing male and female genitalia. *o.*—ovary; *r.s.*—receptaculum seminis; *s.v.*—seminal vesicle; *t.*—testes; *v.g.*—vitelline gland; *w.v.*—water vessel. × 230.

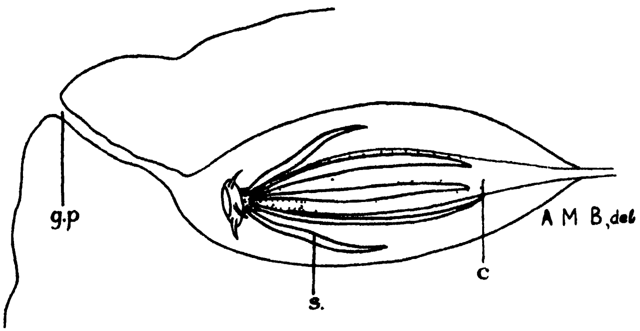

FIG. 9. *Choanotaenia microsoma*, n.sp. Showing spines on cirrus. *c.*—cirrus; *g.p.*—genital pore; *s.*—spine. × 750.

parallel to the cirrus (fig 9). The vas deferens dilates close to the median extremity of the cirrus pouch into a small seminal vesicle, and then continues in the median direction as a very fine tube (fig. 8).

Ovary. This organ lies quite anterior and is divided into two sets of acini, one on each side, widely separated from each other (fig. 8).

Receptaculum and vagina. The vagina is a wide muscular tube running posterior to the cirrus pouch and dorsal to the excretory vessel. Near the centre of the segment it dilates into a globular receptaculum, having a diameter of about 36μ (fig. 8).

Vitelline gland. This is a compact, deeply-staining organ lying posterior to a line joining the two wings of the ovary. It has a breadth of about 110μ (fig. 8).

Shell gland. This lies immediately anterior to the vitelline gland. It is somewhat globular and has a diameter of about 30μ.

Uterus. The uterus appears suddenly as a transverse sac situated in front of the ovary. In the next segment the ovary and testes have entirely and as suddenly disappeared, the whole segment being occupied by the uterus which extends beyond the water vessels. The eggs lie in capsules, one in each capsule.

DIAGNOSIS

The characters which distinguish this worm from other species of the genus *Choanotaenia* are: (1) its small size; (2) the small number of segments; (3) the number, size and shape of the hooks; (4) the peculiarly armed cirrus.

On account of its small size I have named it *Choanotaenia microsoma.*

Cyclorchida omalancristrota (Wedl, 1856), Führmann, 1907

Several specimens from intestine of *Platalea* sp. (spoon bill). Zoological Gardens, Calcutta. Collected by the author, 21.11.13.

Sub-family *PARUTERININAE*, Ransom, 1909

Rhabdometra tomica, Cholodovsky, 1906

Two specimens from intestine of *Francolinus pictus* (painted partridge). Zoological Gardens, Calcutta. Collected by the author, 26.3.14.

The number of testes and the arrangement of the transverse and longitudinal muscle fibres left no doubt as to the identification of this species.

Sub-family *HYMENOLEPIDINAE*, Ransom, 1909

Hymenolepis medici (Stoss., 1890), Führmann, 1906

Several specimens from intestine of *Pelicanus philippensis*. Zoological Gardens, Calcutta, 18.9.19.

Hymenolepis fusus (Krabbe, 1869), Führmann, 1906.

1. A large number of specimens from *Larus brunneicephalus*. Zoological Gardens, Calcutta. Collected by the author, 22.1.17.

The hooks varied in size from 12μ to 18μ. It is important to note that of five worms examined, all of them shewed three or four segments with only two testes.

2. A large number of specimens from *Hydropogne caspia* (tern). Zoological Gardens, Calcutta. Collected by the author, 17.2.15.

In six of these specimens it was found that the number of testes was not constant, many segments possessing only two.

Hymenolepis lanceolata (Bloch, 1782), (Weinland, 1858), Braun, 1903

1. Six small specimens 1 cm. long, without heads, from the Black Australian Swan, *Chenopis atrata*, Berhampur, Bengal, numbered Z.E.V. $\frac{6050}{7}$ in the collection of the Indian Museum. Collected by Lt.-Col. Clayton Lane, I M S, 11.4.12.

2. About sixteen small specimens 2 to 3 cms. in length from same host. Zoological Gardens, Calcutta. Collected by the author, 24.4.18.

3. About twelve large specimens, 4 to 6 cms. in length and 1 cm. in breadth from same host. Zoological Gardens, Calcutta, 24.4.19.

4. About twenty large specimens, about 6 cms. in length and three small specimens, 2 cms. in length from *Cygnus atratus*. Zoological Gardens, Calcutta, 22.12.19.

5. Four large specimens, 4 to 6 cms. in length from the Black Swan. Zoological Gardens, Calcutta, 25.5.19. The variability of this species is discussed by Maplestone and Southwell in *Ann. Trop. Med. & Parasit.*, June, 1922.

Hymenolepis naja (Duj, 1845), Führmann, 1906

1. Three fragments from intestine of *Copschychus saularis* (Magpie robin). Zoological Gardens, Calcutta. Collected by the author, 5.8.15. All the fragments were stained and mounted.

2. Two specimens, one with a head, from *Sitta chinensis* (green

magpie). Zoological Gardens, Calcutta. Collected by the author, 27.4.15. Both specimens were stained and mounted.

Hymenolepis zosteropis, Führmann, 1918

1. A large number of specimens from *Criniger flaveolus* (white cheeked Bulbul). Zoological Gardens, Calcutta. Collected by the author, 26.12.19. Our specimens measured from 2 mm. to 4 mm. in length ; the hooks were very typical of the species.

2. About ten specimens from intestine of *Melophus melanicterus*. Zoological Gardens, Calcutta. Collected by the author, 25.6.15.

3. Four specimens from intestine of *Closa* (?) *chinensis* (green magpie). Zoological Gardens, Calcutta. Collected by the author, 28.4.15.

4. Five specimens from intestine of *Ploceus atrigula* (the eastern baya). Zoological Gardens, Calcutta. Collected by the author, 12.10.15.

5. Three specimens from intestine of *Melophus melanicterus* (the crested bunting). Zoological Gardens, Calcutta. Collected by the author, 25.6.15.

6. Six specimens from intestine of *Dendrocitta* sp. (tree-pie). Zoological Gardens, Calcutta. Collected by the author, 15.5.13., and numbered Z.E.V. $\frac{5953}{7}$ in the collection of the Indian Museum.

Hymenolepis farciminalis (Batsch, 1786) (R. Blanchard, 1891), Führmann, 1906

Several specimens from intestine of *Pica rustica* (magpie). Zoological Gardens, Calcutta. Collected by the author, 10.7.18.

A striking feature of our specimens of this species was the fact that a single strobila contained segments with no testes, and segments with one, two, three or four testes, although most segments contained three. Another feature was that the testes in some segments were in line, in other segments there were two testes aporal and one poral, and vice versa. In fact their disposition was quite irregular.

Hymenolepis stylosa (Rud., 1810), Volz., 1899

1. Several specimens from intestine of *Brackypternus aurantius* (golden backed wood-pecker). Zoological Gardens, Calcutta. Collected by the author, 31.12.13.

2. Four specimens (only one with a head) from intestine of *Trochalopterum meridionale* (laughing thrush). Zoological Gardens, Calcutta. Collected by the author, 9.8.15.

3. Two young strobilae (2 cms. long) from intestine of *Pica rustica.* Zoological Gardens, Calcutta. Collected by the author, 10.7.18. These were mounted.

Hymenolepis capillaroides, Führmann, 1906

1. Three specimens (one with a head) from intestine of a snipe. Berhampur, Bengal. Collected by Lt.-Col. Clayton Lane, I.M.S., 21.7.12.

2. Two specimens, one with a head, same host and locality. Collected by Lt.-Col. Clayton Lane, I.M.S., 12.3.12.

Hymenolepis (? *asymetrica*), Führmann, 1918

Three badly preserved specimens, apparently of this species (only one with a head) from intestine of *Urocissa occipitalis* (red-billed blue magpie). Zoological Gardens, Calcutta. Collected by the author, 22.10.19

Führmann obtained the species from *Chalcococcyx plagosus*, New Guinea. His specimens measured 10 cms. in length and 1 mm. in breadth. The head was armed with 10 hooks 19μ long, and of a peculiar shape. Our specimen was armed with exactly similar hooks of the same size. The Indian specimens measured 1 cm. only in length and were quite immature. In the posterior segments the testes were developing and the rudiments of the ovary could be seen.

Hymenolepis (? *microcephala*) (Rud, 1819), Führmann, 1906

Numerous specimens from intestine of *Ciconia alba* (white stork). Zoological Gardens, Calcutta. Collected by the author, 6.6.19.

Hymenolepis (? *simplex*)

1. Two fragments and one head from intestine of *Tadorna cornuta* (sheldrake). Zoological Gardens, Calcutta. Collected by the author, 26.3.15.

2. Numerous specimens without heads from same host and locality, 18.3.14.

Hymenolepis spp.

1. A few fragments of a small worm apparently about 12 mm. in length, from the intestine of *Emberiza luteola.* Zoological Gardens, Calcutta, 11.11.15. The fragments were in a bad state of preservation. No head was present ; there appeared to be three testes in the segments examined.

2. Other fragments also without heads from intestine of *Garrulax belangeri*. Zoological Gardens, Calcutta, 1.5.19.

3. Still others from intestine of *Oriolus melanocephalus*. Zoological Gardens, Calcutta, 12.10.15.

4. One specimen without head from intestine of *Liothrix lutia* (red-billed Liothrix). Zoological Gardens, Calcutta. Collected by the author, 29.5.16. The specimen measured 30 mm. in length and 2·5 mm in breadth. Two testes were situated on one side and one on the other.

5. Fragments from intestine of *Dendrocitta rufa*. Zoological Gardens, Calcutta, 13.6.15.

6. Several specimens without heads from intestine of *Tadorna cornuta* (common sheldrake). Zoological Gardens, Calcutta. Collected by the author, 18.3.14.

7. Two specimens without heads from same host and locality. Collected by the author, 23.6.15. In both specimens the testes were irregular, the conditions being similar to those described for *H. farciminalis*.

HYMENOLEPIS ANNANDALEI, n.sp.

Two specimens from the intestine of *Limosa belgicae* (black-tailed godwit). Barkuda, Chilka Lake, Orissa, India. Collected by Dr. N. Annandale, 28.4.28.

External Anatomy

The specimens had the following dimensions :—

	Length				Greatest breadth
1.	60 mm.	...	...	...	1·5 mm.
2.	103 mm.	...	...	...	2 mm.

The anterior part of the worm is attenuated and whip-like ; all the segments are broader than long, the posterior and lateral margins being salient. The genital pores all unilateral, and situated slightly anterior to the middle of the lateral margin.

Head. The head measures about 180μ in length and is 150μ broad ; the suckers have a diameter of about 80μ. The rostellum is a conspicuous organ armed with a single row of 10 hooks which measure about 32μ in length (fig. 10). Both in size and shape they closely resemble those of *H. brasiliense*, Führ.

The neck measures about 2 mm. in length.

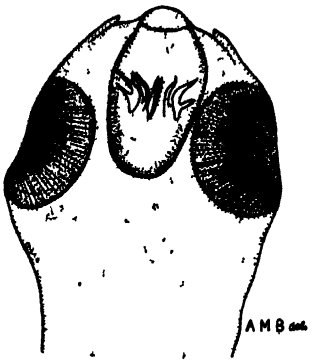

FIG. 10. *Hymenolepis annandalei*, n.sp. Showing head. × 220.

INTERNAL ANATOMY

Muscular system. This is poorly developed. The longitudinal muscles consist of an inner and an outer series of bundles ; the internal bundles are larger and fewer than the outer bundles, the latter being situated immediately beneath the cuticle. A few circular fibres occur between the outer and inner longitudinal bundles and also internal to the inner longitudinal fibres. No oblique fibres were seen (fig. 12).

Nervous system. Details of this system were not investigated. A small ill-defined nerve was observed in transverse sections, running external to the water vessel on each side.

Water vascular system. This consists of a single ventral vessel on each side, lying ventral to the cirrus pouch and vagina (fig. 12).

Genitalia. Testes. There were three testes ; one is situated on the pore side and the other two are aporal, one being anterior to the other (figs. 11 and 12). When fully mature they have a diameter of about 150μ and occupy almost the whole of the segment dorso-ventrally.

Vas deferens. The cirrus pouch lies dorsal to the vagina ; it is somewhat club-shaped, the broader extremity being median. It measures about 180μ in length and its greatest breadth is about 40μ. Its median half is occupied by an internal seminal vesicle. In the median direction it continues as a very short, wide, coiled tube and then dilates into a large external seminal vesicle which measures about 160μ in length and 30μ in breadth (fig. 12) ; the median extremity of the external seminal vesicle is close to the poral testis.

Ovary. The ovary is situated ventrally in the middle line, and posterior; it measures about 300μ broad and 100μ in the antero-posterior direction, whilst dorso-ventrally it practically fills the segment (fig. 11).

Receptaculum and vagina. The vagina is a very muscular organ measuring about 450μ in length and is club-shaped. At the pore its breadth is about 10μ; it gradually widens and attains a maximum diameter of 50μ at a point opposite the middle of the external seminal vesicle. It then narrows gradually. The whole vagina functions as a receptaculum.

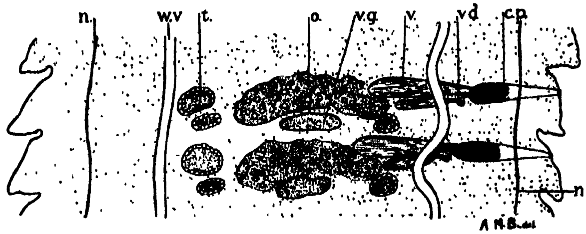

FIG. 11. *Hymenolepis annandalei*, n.sp. Horizontal section showing genitalia. *c.p.*—cirrus pouch; *n.*—nerve; *o.*—ovary; *t.*—testes; *v.*—vagina; *v.d.*—vas deferens; *v.g.*—vitelline gland; *w.v.*—water vessel. × 60.

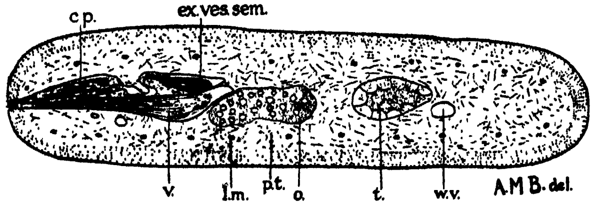

FIG. 12. *Hymenolepis annandalei*, n.sp. Transverse section showing cirrus pouch, vagina and the great development of parenchymatous tissue. *c.p.*—cirrus pouch; *ex.ves.sem.*—external vesicula seminalis; *l.m.*—longitudinal muscle; *o.*—ovary; *p.t.*—parenchymatous tissue; *t.*—testes; *v.*—vagina; *w.v.*—water vessel. × 72.

Vitelline gland. This is a conspicuous bi-lobed organ situated posterior to the centre of the ovary. It is about 100μ broad (fig. 11).

Uterus. The uterus consists of a simple transverse sac extending well beyond the water vessel on each side, and almost to the edge of the segment. The eggs were not mature; the largest measured 17μ in diameter and the onchosphere measured 11μ (fig. 13).

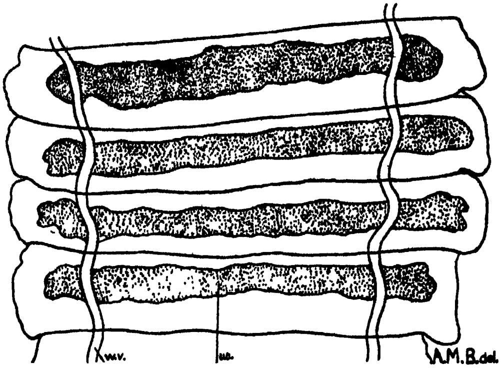

FIG. 13. *Hymenolepis annandalei*, n.sp. Whole segments showing fully developed uterus. *ut.*—uterus; *w.v.*—water vessel. × 35.

DIAGNOSIS

The worm bears a very close resemblance to *H. brasiliense*, Führ. The only difference between them is that in Führmann's species the testes are in a line, whilst in *H. annandalei*, n.sp., this is not the case.

I have pleasure in naming this species in honour of Dr. Nelson Annandale, Director of the Zoological Survey of India.

Sub-genus *Echinocotyle*, Blanchard, 1891

Echinocotyle uralensis, Clerc, 1902

1. One specimen from intestine of snipe. Potsengbam, near Loktak Lake, Manipur, Assam (2600 feet), Station 1. Manipur Survey, 14.2.20.

This specimen agreed with Clerc's description, except that the hooks when isolated measured up to 74μ. In the type species they measure from 54μ to 66μ. In some segments testes were entirely absent; two other segments contained only one in each, and in four or five other segments the posterior aporal testis was absent.

2. One specimen from gut of a snipe. No further data given.

3. One specimen, without head, from *Gallinago* sp. (snipe). Berhampur, Bengal. Collected by Lt.-Col. Clayton Lane, 12.3.12.

4. Two specimens (one with a head) from intestine of a snipe. Berhampur, Bengal. Collected by Lt.-Col. Clayton Lane, (No. 219b), 17.12.12

Family *TAENIIDAE*, Ludwig, 1886

Diploposthe laevis (Bloch, 1782), Jacobi, 1896

1. One complete specimen from intestine of *Netta rufina* (red-crested pochard). Zoological Gardens, Calcutta. Collected by the author, 29.1.14. The specimen was stained and mounted.

2. Fragments from intestine of *Nyroca ferina*, Chilka Lake, Orissa, India, 24.11.14. Numbered Z.E.V. $\frac{6874}{7}$ in the collection of the Indian Museum.

Diploposthe sp. (? *laevis*)

A fragment from intestine of *Strepsilas interpres* (turnstone plover). Chilka Lake, Orissa, 24.11.14. (Chilka Survey).

Family *ACOLEIDAE*, Ransom, 1909

Dioicocestus novae guineae, Führmann, 1914

1. Three specimens from intestine of *Podiceps albipennis* (the little grebe). Zoological Gardens, Calcutta. Collected by the author, 1.5.17.

They had the following measurements :—

TABLE III.

Number	Length	Breadth	Thickness
1. Male	10·0 ccms.	5·0 mm.	about 1·0 mm.
2. Male	10·0 cms.	3·5 mm.	about 1·0 mm.
3. Female	17·0 cms.	5·9 mm.	1·6 mm.

The head of the female worm (No. 3) is armed with at least 12 hooks, 320μ long (fig. 14). Possibly a few hooks were missing. In shape these

FIG. 14. *Dioicocestus novae guineae*, Führmann. Showing hook. × 80.

hooks are similar to those figured by Lühe for *D. aspera* (Mehlis), but in the latter species they measure only 200μ to 218μ, and are 14 in number. In the male specimens (Nos. 1 and 2) the hooks were missing, but the

impressions made in the parenchyma by these hooks were clearly visible. The only trace of genitalia in these two male strobilae consists of two cirrus pouches in each segment, each of which measures 750μ in length and 330μ in breadth. No spines were seen on the cirrus although carefully looked for. In the female strobila the ovary had almost entirely degenerated. There were a number of gravid segments; the eggs measured about 50μ and the onchosphere 28μ.

Four species of this genus are now known (Table IV).

TABLE IV.

Species	Locality	Host	Male		Female		Rostellum	Suckers
			Length	Breadth	Length	Breadth		
D paronai ...	Argentine	*Plegadis guarauna*	mm. 70	mm. 4·0	mm. 60	mm. 5·0	Practically absent	Practically absent
D. acotylus ...	Jamaica, Brazil	*Podicipes dominicus*	45-130	2-2·5	100-190	3·5-4·0	Very small	Very small
D. aspera ..	Europe	*Lophaethyia cristata* and *L griseigena*	280	6·0-9·0	340	8·0-11·5	Well developed with 14 hooks 200-218μ in length	Well developed
D. novae guineae	New Guinea	*Podicipes novae hollandiae*	60	3·5	50	4·5	Moderately developed with 18-20 hooks	Moderately developed

As the Indian specimens have well-developed suckers and a large rostellum, they are closely related to *D. aspera* and *D. novae guineae.* They differ from the former in size and in possessing larger hooks, and agree with Führmann's description of the latter genus. No hooks were present in Führmann's specimens.

2. A second very young female specimen of what I believe to be this species was obtained from the same host and locality, by Dr. Baini Prashad, 2.2.18. The specimen was strongly contracted and was ripe, but no gravid segments were present. It was sectioned and mounted.

Cestode sp.

A few fragments from *Sterna fluviatilus.* Zoological Gardens, Calcutta, 3.1.15.

Order *PSEUDOPHYLLIDAE*, Carus, 1863

Family *DIPHYLLOBOTHRIIDAE*, Lühe, 1910

Genus *Ligula*, Bloch, 1782

Bothria as well as external segmentation completely absent from the larvae ; both develop simultaneously with the maturation of the sex-organs in the definitive host, where the external segmentation which does not correspond with the internal is confined to the anterior end. Longitudinal and transverse muscles irregularly interwoven in the anterior end, posteriorly separated into an inner transverse and an outer longitudinal layer.

Type (and only) species : *Ligula intestinalis* (L).

Ligula intestinalis (Linnaeus, 1758)

Three larval forms from the coelome of three specimens of *Danio acquipinnatus* (McClelland), collected by S. L. Hora, Esq., Indian Museum ; Pung-Ka-Mem-John stream, Cherrapunji, Khasi Hills, Assam, 28.10.21, and numbered W $\frac{423}{1}$ and W $\frac{424}{1}$ in the collection of the Indian Museum.

Lühe in 1898 arrived at the conclusion that there is only one species of *Ligula*, and this conclusion was accepted by Linstow in 1901 and by Cooper in 1918.

The synonomy of both the larval and adult forms is very extensive, and a complete list is given by Cooper (1918). The larval forms occur in the body cavity of Teleosts and the adults occur in the intestine of wading and diving birds.

Our specimens are typical in every respect and call for no comment.

The author has previously (1913) recorded the occurrence of this larva in the intestine of the following Indian fishes, viz., *Labeo calbasu* and *Nemachilus rupicola*.

Another larval form, viz., *Schistocephalus solidus*, occurs much less commonly in the abdominal cavity (and occasionally in the stomach and intestine) of bony fishes, but the larval form of this species is characterised by the fact that it is definitely segmented, and possesses two bothria, whereas in *Ligula intestinalis* bothria and all traces of external segmentation are absent.

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A NEW MALARIA PARASITE OF MAN

BY

J. W. W. STEPHENS

(*Received for publication* 3 *October*, 1922)

PLATE XVI

During the course of experimental work on the treatment of malaria, carried out at the Liverpool School of Tropical Medicine from 1917 to 1921, it was the practice always to control the clinical results of treatment by microscopical blood examinations.

Occasionally—perhaps some half-dozen times—parasites other than 'ring' forms were found in films, and doubt arose as to whether they were quartan or simple tertian.

The present paper concerns the parasites found in one such case.

Private J.——, 188817.

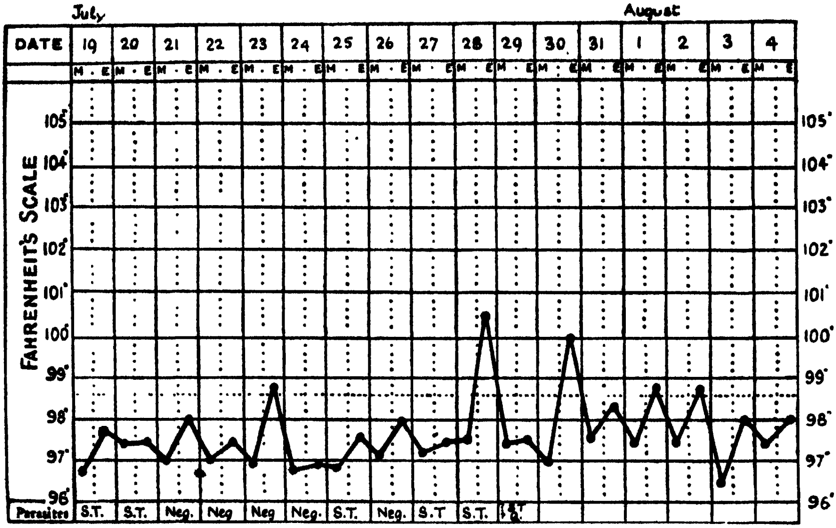
December, 1916	'Malaria,' East Africa.
January, 1918	Left East Africa.
8.4.18 to 11.4.18 and 27.7.18 to 4.5.18	The blood films for these dates, made for the purpose of counting the leucocytes, are still in existence and show Simple Tertian parasites.
19.7.18 to 20.7.18	The films still in existence show Simple Tertian parasites.
21.7.18 to 24.7.18	The entry made in the Card Index was 'Negative.'
28.7.18	The entry was '? Simple Tertian.'
29.7.18	The entry was '? Simple Tertian, ? Quartan.'

A re-examination of these two latter films, still in existence, show peculiar forms.

30.7.18 to 3.8.18	Owing to the doubt as to the nature of the parasites found, and from the fact that this was not the first time that such doubt had arisen, a series of films approximately at 4-hourly intervals during the daytime was made on the above dates. They were stained for 1 hour with Leishman's stain, and show perfectly well at the present time the characters to be described.

The Temperature Chart of 28.7.18 to 30.7.18 (fig. 1) shows a tertian periodicity, and the parasite findings for these days are as follows:

28.7.18	9 a.m.	Young forms absent. Incompletely segmented forms with 6-8 chromatin masses.
29.7.18	... ...	Young forms in successive stages of growth during the day.
30.7.18	9 a.m.	Incompletely segmented forms.
	1 p.m.	Completely segmented forms and young rings.
1.8.18	2 p.m.	Completely segmented forms and young rings again present.



The periodicity of the parasite appears therefore to be tertian. Although a cycle of development is passed through from 30.7.18 to 1.8.18 the temperature on the latter date reaches only 98·8° F.

THE PARASITE

Young forms.

Small 'rings' indistinguishable from 'rings' of other species, or round or oval forms with little or no clear area ('vacuole') around the nucleus. No indication of amoeboid activity as judged by irregularity of form. The red cells in which the parasites occur are not uncommonly *oval* with irregular margins—*fimbriated.* At this stage the cells are not enlarged and (generally) show no Schüffner's dots.

Medium-sized forms.

These are the characteristic forms. They resemble rather closely quartan parasites in the appearance they present of 'solidity' or 'compactness,' and the amount of chromatin and the distribution of the pigment in a lateral band are appearances that recall quartan, but no band-like or 'meridional' forms, as seen in the case of the quartan parasite, were found. They are globular or oval, and occur so frequently in *oval* red cells that it can hardly be a matter of chance but one of actual significance. In forms with one chromatin mass this is often lateral and roughly triangular. There is a complete absence of the irregular, fantastic, 'straggling' parasitic forms occurring in cells of not uncommonly twice the normal diameter so characteristic of simple tertian parasites. Schüffner's dots are now well marked.

Segmenting forms.

The gradual transition from young rings to segmenting forms can be traced with ease and certainty. The maximum number of segments (merozoites) appears to be 12. Forms occur with as few as 6 nuclear masses and with the pigment concentrated into a single mass, but it is impossible to be certain in the absence of complete segmentation of the protoplasm whether division is completed. The cell in which these forms lie is either normal in size or slightly enlarged. A slight margin showing Schüffner's dots is often seen, and the cell is clearly decolorized.

The characteristics then of this parasite so far as concerns the medium forms are a non-amoeboid, pigmented, compact, round or oval parasite, resembling quartan, in a red cell showing Schüffner's dots, which is either normal in size or only slightly enlarged. The pigment, so far as can be judged in stained specimens, appears to be brownish black, and granular rather than spicular. A double infection of a red cell was only seen once, viz., with 2 contiguous quarter-grown oval parasites in an oval cell.

No forms that could be interpreted as gametes were seen.

Now and then, but it has been a rare occurrence, I have encountered a form which I could not distinguish from simple tertian.

This parasite appears to resemble that found by Ahmed Emin in 1914 in the case of six pilgrims at Camaran in the Red Sea, and figured and described by him as *Plasmodium vivax*, var. *minuta*. I have been unable

to procure Ahmed Emin's specimens for examination, so cannot come to a decision as to the identity of his parasite with the present one.

The characters of this parasite appear to me to be different from any of the usually accepted species and I propose to call it *Plasmodium ovale.*

REFERENCE

AHMED EMIN (1914). Une variété nouvelle du parasite de Laveran. *Bull. Soc. Path. Exot.*, Vol. VII., p. 385.

EXPLANATION OF PLATE XVI

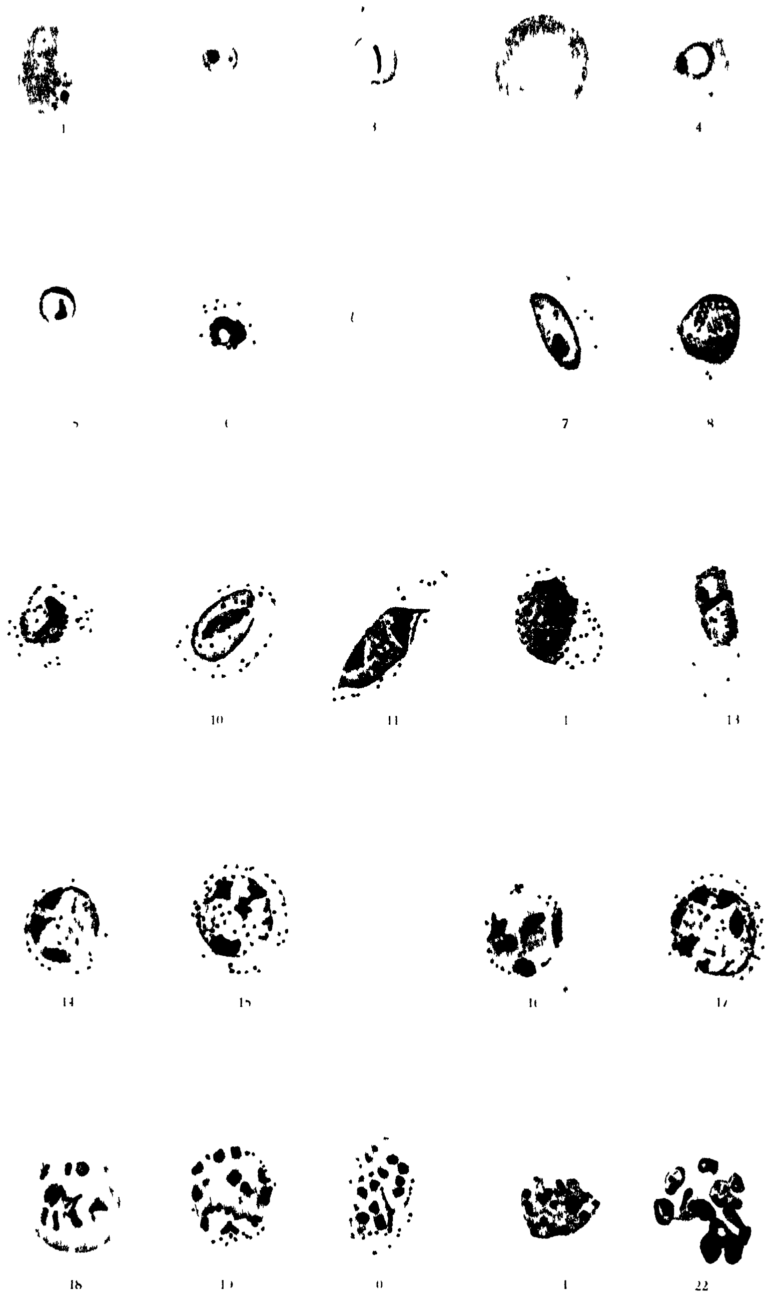
Plasmodium ovale, n.sp. × 1800

Figs. 1—5 ' Ring ' forms

Figs. 6—13. Medium forms.

Figs 14—22. Pre-segmenting and segmenting forms.

PLATE XVI



NOTES ON THE BIONOMICS OF *STEGOMYIA CALOPUS*, MEIGEN, IN BRAZIL

PART I

BY

C. J. YOUNG

From the Research Laboratory of the Liverpool School of Tropical Medicine, Manáos, Brazil

(*Received for publication* 21 *October*, 1922)

The following work, which was carried out in Manáos, does not attempt to deal comprehensively with the bionomics of *Stegomyia calopus*, but is mainly concerned with various points which attracted attention while breeding these mosquitoes in the laboratory. It was undertaken chiefly owing to the noting of some slight differences in the bionomics of this mosquito, as compared with those observed in certain other countries.

The factors influencing the bionomics of *S. calopus* have been shown to be complex, and, owing to its sensitiveness to environmental conditions, it is doubtful if conclusions can be drawn from the comparison of experiments which have not been carried out under similar conditions of time, place, etc. The effects of many of these factors may be studied by comparison with controls, the only difference between the control and the subject of the experiment being the factor under investigation. Where applicable, this method was adopted in the following experiments.

METHODS

The adult mosquitoes were kept in wire-gauze cages, and fed on sugar solution. When eggs were required they were allowed to feed on human blood. In the experiments, eggs and larvae were kept in glass jars on a bench in the laboratory, and those used in any one experiment in which a comparison was to be made were kept together, so that the temperature and amount of light reaching each one were the same.

Except where otherwise stated, larvae which hatched out were removed every twenty-four hours. The eggs used in each experiment where comparisons are made were from the same batch of eggs, but not necessarily from the same adult, the eggs being mixed before distribution. They were always less than twenty-four hours old at the beginning of each experiment.

TEMPERATURE

The temperature range in Manáos throughout the year is small. According to official figures from 1902 to 1914, the average of the annual mean temperature was 28·2° C., the absolute maximum 38·6° C., and the absolute minimum 18·8° C. During the experiments the laboratory temperature varied between 33° C. and 24·5° C. The temperature of the water in the jars was always found to be within 2° C. of the atmospheric temperature, and was frequently the same. The daily range of the laboratory temperature was usually less than 6° C.

LAYING OF EGGS

Fielding (1919) and Bacot (1916) found that females preferred contaminated water to clear for laying eggs in. A few experiments were carried out to discover if this preference existed in Manáos.

Watch glasses containing the waters to be compared were placed in the breeding-cage, losses due to evaporation being replaced from time to time. The results, which are given in Table I, are similar to those of Fielding and Bacot.

TABLE I.

Laying of Eggs in Different Waters.

Duration of Experiment	Contents of Glass	No of Eggs laid	Percentage of Total
72 days	Tap water	560	26
	River water	1590	74
	Tap water	563	10·6
32 days	River water	1682	31·5
	Water from cesspool	3092	57·9

Bacot states that it is misleading to say that the eggs are deposited on the surface of water, as in the great majority of cases they are to be found on the wet margins of the receptacle or other object, and that no instance of an egg being laid on a dry surface was observed.

In the following experiment it was found that in captivity the majority of eggs were laid on a damp surface, when available. A watch glass containing rain water and a piece of blotting paper floating on it, the areas of the blotting paper and the water surface exposed being approximately equal, was placed in the breeding-cage. The results are shown in Table II.

TABLE II.

The Numbers of Eggs laid on Water and on a Damp Surface.

Duration of Experiment	Eggs found		
	On Blotting Paper	On Water	On Dry Glass
44 days	1966	568	88

No mosquitoes were observed laying eggs on a dry surface, and those found dry were probably stranded by capillary attraction and left above water level by evaporation. This could not occur with the blotting paper, as it was floating. Fielding's findings in Queensland were similar.

So far as hatching was concerned, no difference was found between those laid on the moist blotting paper and those laid on water.

Wild *Stegomyia* have been observed on several occasions laying eggs in barrels standing in the enclosure behind the laboratory. The eggs were always laid on the wet sides of the barrel just above the water surface. In glass jars placed outside, eggs were laid on the water, usually near the sides, and many adhered to the jar as the water evaporated.

HATCHING OF EGGS

Difficulty was at first experienced in getting eggs which were left floating as laid, to hatch. An attempt was, therefore, made to discover the cause of this, and several factors were found to

influence the hatching. Those investigated were, position of the eggs (floating or submerged), presence or absence of disturbance, presence or absence of food, and the nature of the water. Many other factors, such as bacterial action, formalin, temperature, humidity, drying, lysol, petroleum, soft soap emulsion, and soap solution, are stated to influence the hatching of the eggs.

Many experiments were carried out, all of which are not given below, but the following illustrate the points mentioned.

Hatching of Floating and Submerged Eggs

Fielding (1919) in Queensland, and Bacot (1916) in West Africa, found no difference in the hatching of floating and submerged eggs. In Manáos the difference was definite. Even under the most favourable conditions, floating eggs only occasionally hatched.

A batch of fifty-four eggs laid during the previous twenty-four hours were divided into two equal lots. Each lot was placed in a jar containing tap water (7·4 c.c. per egg), rice was added and the eggs were agitated by stirring daily for one minute. One lot was submerged on the first day, and the other left floating for twenty days. The results are shown in Table III.

Table III.

Hatching of Floating and Submerged Eggs.

Eggs floating for 20 days.	27	Eggs submerged on 1st day	27
Hatched by 20th day	0	Hatched by 20th day	77%
Hatched after submergence ...	96%	Hatched by 39th day	96%

This result has been confirmed by similar experiments with and without added food, and disturbance, and in rain water, but occasionally a few eggs hatched. Why some eggs hatched when floating, although the majority did not, is not apparent.

Under natural conditions the eggs were observed to be

submerged by various agencies, chief of which appeared to be rain. In Manáos rain falls at all seasons.

Jars containing eggs were exposed to rain with the following results:—

41	eggs	out of	56	were submerged	by	15	minutes	rain.
25	,,	,,	26	,,	,,	5	,,	,,
18	,,	,,	27	,,	,,	5	,,	,,

Eggs laid or becoming stranded on the sides of the receptacle became attached when dry, and when the water rose again remained attached and were therefore submerged. Fully developed larvae usually, but not always, submerged floating eggs, seizing the eggs with the mouth, pulling them below the surface and releasing them.

The following results were obtained:—

4	larvae	submerged	89	out of	110 eggs in 2 days.
4	,,	,,	19	,,	remaining 21 eggs in 27 days.
6	,,	,,	34	,,	34 eggs in 24 hours.
4	,,	,,	4	,,	27 eggs in 11 days.

The reason for the differences shown is not known.

Floating eggs were also found to be submerged by insects falling into the water.

Effects of Disturbance on Hatching

Mitchell (1907), in the United States, records that Duprée found agitation to be a great factor in the hatching, and that if left undisturbed eggs may remain unhatched for over a year. Bacot (1916), in West Africa, failed to obtain a decisive result on this question of agitation, and also (1918) casts doubt on the value of Mitchell's records.

In Manáos the majority of eggs did not hatch unless disturbed. It has already been stated that floating eggs did not usually hatch, even when disturbed. When submerged before they were ready to hatch and left undisturbed, they also usually remained unhatched when no food was added. This is shown in Table IV.

TABLE IV.

Effects of Agitation on Hatching in the Absence of Added Food.

Nature of water		Submerged 1st day No food added		Control Food added
		Not Agitated	Agitated	Agitated
Tap water	No. of eggs	50	30	17
	Hatched in 1 month	2%	10%	100%
Rain water	No. of eggs	140	30	25
	Hatched in 1 month	0	33%	96%

In this experiment two batches of eggs were used, one in tap water and the other in rain water. The control was merely to demonstrate that the eggs were fertile under favourable conditions. The agitation consisted of stirring for one minute daily. The amount of water per egg was the same for each batch.

In the following experiment shown in Table V, some hatching took place in the presence of added food, but less so than among the controls. Rice was added to each jar, and all eggs were submerged on the first day.

TABLE V.

Effects of Agitation on Hatching in the Presence of Added Food.

Water	230 c.c. in each jar	Not Agitated	Agitated
Rain water	No. of eggs	30	30
	Hatched in 12 days ...	40%	100%

It may be added that a further 36 per cent. hatched when agitation was provided.

Various methods of providing disturbance were tried. The dropping of water into the jar so as to submerge the eggs was usually followed, in the presence of food, by the hatching of the majority when they were four days old. Rain had a similar effect. A jar containing twenty-six eggs, four days old, floating in tap water, was placed in rain for five minutes. Twenty-five eggs

were submerged, and within four hours eighteen larvae were removed. A control showed no hatching.

Stirring or aerating the water for one minute daily, or the addition of one or more larvae, provided an effective stimulus. In the presence of added food, the disturbance caused by larvae appeared to be only slightly more effective than one minute's stirring, as shown in Table VI.

TABLE VI.

Larvae *v.* Stirring in the Hatching of Eggs in Presence of Added Food.

Two fully-grown larvae present		Stirred one minute daily	
No. of eggs	30	No. of eggs	30
100% hatched in	5 days	100% hatched in	8 days

Each jar contained 230 c.c. of rain water. The eggs were submerged at the beginning of the experiment.

In tap water little difference was observed, the larvae hatching the eggs slightly faster. In the absence of added food, however, larvae were more effective, as shown in Table VII.

TABLE VII.

Larvae *v.* Stirring in the Hatching of Eggs in Absence of Added Food.

Two fully-grown larvae present		Stirred for one minute daily	
No. of eggs	30	No. of eggs	30
Hatched in 18 days	76%	Hatched in 18 days	10%
Total hatched after addition of rice	96%	Total hatched after addition of rice	90%

Each jar contained 230 c.c. of tap water. The eggs were submerged at the beginning of the experiment.

A similar result was obtained in rain water. In these experiments fully grown larvae which pupated or died were replaced by others. It seems probable from these and other results that the larvae, possibly through their excretions, had an effect on the eggs similar to that of the addition of food.

Effects of Food on Hatching

In Table VIII it is shown that the addition of rice rendered the conditions more favourable to hatching.

Table VIII.

Influence of Addition of Rice on Hatching.

Rice added	0	50 mgms
No. of eggs in each jar	30	30
Hatched by 20th day	33%	90%
Hatched after addition of rice	83%	—

The eggs were floating till submerged on the fourth day, after which they were stirred daily for one minute. Each jar contained 230 c.c. of rain water.

In other experiments where rice had not at first been used, but other conditions suitable to hatching were present, its addition was invariably followed by hatching, comparison with controls indicating that the hatching was due to the addition of the rice.

Effects of Differences in Water on Hatching

Tap water containing more organic matter than rain water might have been expected, on grounds of possible food supply, to be more suitable for the hatching of eggs than rain water. The latter was, however, found to be preferred by the mosquito for laying eggs on, and to be more suitable for the hatching and development of larvae. Tap water consists, in Manáos, of sedimented river water, an analysis of which, made by Mr. W. J. Debdin, F.I.C., F.C.S., has been published by Thomas (1910). According to this analysis the water contained a considerable amount of albumenoid ammonia, apparently derived from vegetable matter, no nitrates, but *B. coli* in 0·1 c.c., and in other ways, resembles what is usually described as a peaty water.

Where conditions were favourable for hatching, all, or nearly all, eggs hatched, whether in tap or rain water. In Table IX are shown the results of an experiment in which the conditions were favourable,

there being 50 mgms. of rice in each jar; the eggs were submerged on the fourth day, and two larvae were added to each jar.

TABLE IX.

Hatching of Eggs in Different Waters under Favourable Conditions.

Nature of water (7 c.c. per larva)	Rain water	Tap water
No. of eggs in each jar	30	30
Hatched by 5th day	100%	93%

Where conditions were less favourable, eggs hatched more readily in rain water, as shown in Table X. Here no food and no larvae were added. The eggs were floating till submerged on the fourth day.

TABLE X.

Hatching of Eggs in Different Waters under less Favourable Conditions.

Nature of water (4·6 c.c. per larva)	Rain water	Tap water
No. of eggs in each jar	50	50
Hatched by 5th day	52%	22%

Similar results were obtained under other conditions, and it will be shown subsequently that larvae developed more quickly in rain water.

VIABILITY OF EGGS KEPT IN WATER

It is well known that eggs will hatch after being kept dry for many months. Bacot (1916) stated that some eggs when kept continually immersed did not hatch for periods of from two to five months. This was tested, and the results are recorded in Tables XI and XII. The eggs were stored in the water in jars, which were undisturbed as far as possible and to which no food was added. At the end of each month shown, a number of eggs were removed and examined, the split and collapsed ones being rejected and the others submerged in rain water to which rice was added and stirred daily.

TABLE XI.

Viability of Eggs stored in Tap Water.

	Removed after	No. tested	Hatched	Pupated	Adults
Eggs stored floating ...	4 months	20	45 %	o	o
	5 months	40	15 %	o	o
	6, 7, 8 months	160	o	o	o
Eggs stored submerged	4 months	30	46 %	6·6 %	6·6 %
	5 months	30	20 %	o	o
	6 and 7 months	30	o	o	o

TABLE XII.

Viability of Eggs Stored in Rain Water.

	Removed after	No tested	Hatched	Pupated	Adults
Eggs Stored Floating	3 months	40	92 %	75 %	75 %
	5 months	30	40 %	...	... *
	7 months	25	o	o	o *
Eggs stored submerged	3 months	40	100 %	95 %	95 %
	4 months	40	95 %	95 %	95 %
	5 months	32	56 %	...	... *
	7 months	15	o	o	o *

* These observations were kindly made for me by Dr. R. M. Gordon after my departure from Manáos.

From each of the four batches used in the experiments shown in Tables XI and XII controls were taken and placed under conditions favourable to hatching, and were found to be fertile to the extent of 96 to 100 per cent. adults being eventually produced. Rejections on account of splitting or collapse of the eggs amounted to 7 to 11 per cent. of the eggs in each jar. Of the adults produced, sixty-four were males and forty-four females.

Comparison of the figures in Tables XI and XII would indicate that the eggs retained their viability longer in rain water than in

tap water, but such a comparison is not justifiable as different batches of eggs were used, and the times of the experiments, although overlapping, were not identical.

Eggs were, therefore, found to be able to remain alive for five months in water, either floating or submerged. This accords with Bacot's findings in West Africa. Mitchell (1917) records survival immersed at over a year, but gives no details.

THE DEVELOPMENT OF LARVAE AND PUPAE

The development of *S. calopus* larvae is influenced by the nature of the water, its amount per larva, the presence of food and its nature, and other factors which were not investigated.

In each of the experiments shown in Tables XIII to XVI the larvae used were hatched from the same batches of eggs during the same respective periods, and were all less than twenty-four hours old at the beginning of the experiments.

Nature of the Water

The only waters compared were tap water and rain water. The result is shown in Table XIII. The larvae hatched in the water in which they were subsequently kept. 0·02 per cent. of rice was added to each jar, and the water was aerated daily for one minute by bubbling air through it.

Table XIII.

Development of Larvae in Tap Water and Rain Water.

Water (11 c.c. per larva)	Rain water	Tap water
No. of larvae	24	24
Pupation commenced	10th day	22nd day
Percentage giving pupae	79 %	8 %
Percentage giving adults	79 %	0
Average larval life of those pupating	19·9 days	22·5 days

In the tap water all the larvae became fully developed, but were undersized. The mortality was probably associated in some way

with the water, but larvae were quite capable of developing in tap water when less crowded. Fourteen out of fifteen became adults under similar conditions in tap water where the concentration was 50 c.c. per larva.

Concentration of Larvae

The effects of overcrowding are shown in the following experiments, and indicate that where experiments are carried out to test the values of different foods or waters, the results are not comparable if the concentration of larvae has not been the same in each experiment.

Table XIV.

Result of Varying the Amount of Tap Water per Larva.

Amount of water per larva	50 c c	250 c c.
No. of larvae in each jar	15	15
No. of pupae produced	15	15
No. of adults produced	14 (9♂♂; 5♀♀)	15 (10♂♂; 5♀♀)
Average duration of larval and pupal stages, ♂♂ ...	14·2 days	10·8 days
Average duration of larval and pupal stages, ♀♀ ...	17·8 days	13·c days

This experiment is complicated by the fact that in the jar with 50 c.c. of water per larva there was only one-fifth of the quantity of rice present in the other jar (0·006 per cent.). As it became used up, therefore, rice was added gradually to the former jar till equal quantities had been placed in both without raising the percentage present at any time much above 0·006.

Table XV.

Variation of the Amount of Rain Water per Larva.

Amount of water per larva	15 c.c.	30 c.c
No. of larvae	20	10
No. of pupae produced	19	10
No. of adults produced	19 (12 ♂♂; 7 ♀♀)	10 (5 ♂♂; 5 ♀♀)
Average duration of larval and pupal stages, ♂♂ ...	7·0 days	7·0 days
Average duration of larva and pupal stages, ♀♀ ...	8·3 days	7·4 days

Here the difference is less, possibly owing to more favourable conditions. It was again considered better to provide equal quantities of food per larva in each jar (0·025 per cent. rice and 0·006 per cent. peptone) by gradual addition rather than to commence with a double concentration of food in one jar. The water in each jar was aerated daily for one minute.

Assuming that the method of adding food did not introduce a fallacy, these and other experiments indicate that overcrowding may influence the rate of development.

Nature of Larval Food

A large number of organic substances have been found to be suitable as food for the larvae, but some appear to be more so than others. In the following experiment peptone and rice were compared. Two jars, each containing 400 c.c. of tap water, were taken, and rice was added to one and peptone to the other to the amount of 0·012 per cent. on the first and fourth days of the experiment. An equal number of eggs hatched in each jar during the same period of twenty-four hours. The water was aerated for one minute daily. Details are given in Table XVI.

Table XVI.

Peptone *v.* Rice as a Larval Food.

Food	Peptone	Rice
No. of larvae	19	19
No. of pupae produced	19	19
No. of adults produced	19 (15 ♂♂; 4 ♀♀)	18 (12 ♂♂; 6 ♀♀)
Average duration of larval and pupal stages, ♂♂ ...	7·1 days	8·6 days
Average duration of larval and pupal stages, ♀♀ ...	8·0 days	9·8 days

Thus under these conditions both male and female larvae develop more rapidly on peptone than rice.

Duration of Larval and Pupal Stages

The duration of the larval stages varied enormously under the conditions described above. The shortest time observed was four days in the case of three male larvae, the food used being peptone

(0·006 per cent.) and rice (0·025 per cent.) in rain water (30 c.c. to each larvae). The longest period recorded was also in the case of a male larva, which did not pupate till the forty-second day after hatching and became an adult two days later; in this case the food was rice alone, and the concentration 9 c.c. of rain water per larva. Macfie (1915) states that under 'normal conditions' the larval stage usually lasts seven to thirteen days, and records an instance where it lasted at least ninety-nine days and produced a healthy adult. Bacot (1916) states that under the most favourable conditions the larval life is passed within four days, but with scarcity of food is prolonged for upwards of seventy days.

Table XVII gives the average duration of a considerable number of larvae living under various artificial conditions in the laboratory.

TABLE XVII

Duration of Larval Stage.

Sex	No. of larvae	Average number of days	14 days and under
♂	77	9	90·9%
♀	48	14·6	62·5%
Unrecorded	57	7·3	92·9%
Total	182	9·9	84·0%

The duration of the pupal stage did not vary to any great extent. Figures are given in Table XVIII.

TABLE XVIII.

Duration of Pupal Stage.

Sex	No. of Pupae	1 day	2 days	3 days
♂	96	2	88	6
♀	62	2	53	7
Unrecorded	28	0	17	11
Total	186	4	158	24

Of these figures 85 per cent. took two days, and none took as long as four days. Macfie (1915), in West Africa, records the pupal stage as lasting one to five days, as does Mitchell (1907) in U.S.A.

Table XIX shows the duration of the combined larval and pupal stages.

TABLE XIX.

Duration of Combined Larval and Pupal Stages.

Sex	No. of Larvae	Average number of days	14 days and under
♂	105	10·3	85·7 %
♀	73	14·1	69·8 %
Total	178	11·6	79·2 %

As these records are based on observations made once daily only, and always about the same time, fractions of a day were not recorded. Individuals stated to have taken any particular number of days may be more or less than the number stated by just under twenty-four hours.

SURVIVAL OF PUPAE OUT OF WATER

Fielding (1919) placed five pupae on filter paper which was kept moist. All became adults within four days. Of three pupae placed on wet filter paper, allowed to dry and later removed to water, one hatched after thirty-two hours on the filter paper and two failed to hatch after forty-seven and a half and seventy-two hours. Alcock (1921) records that pupae left on the floor of a cage in London hatched after some delay.

In the following experiments the pupae were placed on blotting paper till dry and then transferred to dry glass tubes.

TABLE XX.

Survival of Dry Pupae.

Duration of pupal stage before drying	Under 24 hours	Over 24 hours, Under 48 hours
No. of pupae	12	3
Result	All died within 48 hours	All hatched within 6 hours

The dry bulb temperature varied between 29° and 25° C. and the wet bulb between 25° and 23° C. during this experiment.

When, however, two lots of dry pupae, four under and four above twenty-four hours, were kept in a dry tube, placed in a stoppered bottle containing water, three hatched out of each lot. It would, therefore, appear that the development of dry pupae was influenced by their age when dried, atmospheric moisture and probably other factors not investigated.

MISCELLANEOUS FACTS

RELATIVE NUMBERS OF MALES AND FEMALES

The relative numbers of males and females bred in the laboratory are given in Table XXI.

TABLE XXI.

Relative Numbers of Males and Females.

Total Adults	No. of Males	Percentage of Total	No. of Females	Percentage of Total
517	323	62·5 %	194	37·5 %

This preponderance of males appeared to be a constant factor under the various conditions employed in the laboratory.

REMOVAL OF EGGS BY ANTS

As Bacot (1916) emphasises the fact that ants in West Africa did not carry off eggs, it is worth noting that in Manáos dry eggs were readily attacked by ants which were observed actually removing them, and batches of dry eggs left exposed on the bench overnight were frequently partly or wholly removed by the following morning.

LAYING OF EGGS WITHOUT FEED OF BLOOD

Fielding (1919) found that eggs were laid when peptone and sugar were given as food without blood. This was tried in Manáos without success, a thick syrup of sugar and peptone being supplied as food in a cage containing about fifty female *S. calopus* and a larger number of males during a period of one month. Eggs were laid when they were allowed to obtain blood. Mitchell (1907) states that *S. calopus* will mate and at times lay without feeding.

OIL AS A LARVICIDE

Macfie (1917), discussing *S. fasciata* larvae imprisoned beneath a film of oil, describes the efforts made by the larvae to reach the surface. He writes as follows :—'So vigorous does the effort appear to be that it seems not improbable that it would eventually break through a thin film of oil.' The latter occurrence was observed in Manáos in the case of larvae breeding naturally in a barrel of water, the surface of which was covered with a thin film of oil. The larvae on ascending for air did not usually succeed in penetrating the surface film at the first attempt, but only after repeated efforts at different parts of the surface. The larvae from this barrel were the largest observed, but of some removed to the laboratory only a few reached the adult stage, the majority dying owing to failure to get clear of their larval or pupal skins. The pupae and adults which developed were also unusually large.

SUMMARY

Various points in the bionomics of *S. calopus* in Manáos have been investigated, and in certain minor respects they differed from those described in West Africa and Queensland. Bacot (1918), in discussing the duration of viability of the eggs of *S. fasciata*, writes, 'It seems to me possible that the African and American races of *S. fasciata*—to suggest no smaller division—may differ considerably in constitution.' It is, however, possible that the differences noted in various countries are due to differences in the conditions under which the experiments were carried out, and, therefore, conclusions cannot be drawn from their comparison.

The following facts were found to apply to *S. calopus* under the particular conditions described above :—

1. The adults laid more eggs in cesspit water than in river or tap water.

2. More eggs were laid on a damp surface than on the water surface.

3. Eggs did not usually hatch when floating.

4. Floating eggs were submerged by rain and *S. calopus* larvae.

5. Adults laid more eggs, eggs hatched earlier and in larger numbers, and larvae developed more rapidly and showed less mortality in rain water than in tap water.

6. Some eggs stored in water, floating and submerged, hatched after five months. None hatched after seven months.

7. Larvae developed more rapidly and showed less mortality with peptone as food than with rice.

8. The larval stage varied from four to forty-two days and the average duration in one hundred and eighty-two larvae was approximately ten days, the average for the females being longer than for the males.

10. The duration of the pupal stage varied from one to three days, 85 per cent. of one hundred and eighty-six pupae taking two days.

11. Pupae dried at least twenty-four hours after pupation developed into adults, although kept dry.

12. Throughout the experiments more males than females were produced.

13. Dry eggs were removed by ants.

14. No eggs were laid by adults fed on peptone and sugar only.

15. It was observed that larvae were capable of obtaining air through a thin film of surface oil.

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THE OCCURRENCE OF THE LARVAE OF *ONCHOCERCA VOLVULUS* (LEUCKART, 1893), IN THE SKIN OF NATIVES OF THE GOLD COAST

BY

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PLATES XVII AND XVIII

The presence of larvae of *O. volvulus* in the skin has been described by Montpellier and Lacroix (1920, 1921) and by Ouzilleau, Laigret and Lefrou (1921). The former authors stated that the larvae caused itching, resulting in the development of an eruption with papules, vesicles and pustules, which they called filarial itch. The latter authors, on the other hand, considered that the larvae produced an inflammatory reaction in the skin, not especially associated with itching, but giving rise to pseudo-ichthyosis, elephantiasis of the skin of the genital organs and of other parts, leucodermia and atrophy. Brumpt (1920) was not satisfied that the larvae, found in the skin by Montpellier and Lacroix, were those of *O. volvulus*. The observations of Ringenbach and Guyomarc'h (1914), Dubois (1916) and Clapier (1917) are not all in agreement regarding the association or otherwise of elephantiasis with infection with *O. volvulus*.

Larvae of *O. volvulus* were found in the lymph glands by Ouzilleau (1913) and by Fülleborn and Simon (1913). They have since been observed by several others.

In the blood they have very rarely been found. Numerous examinations have been made by Ouzilleau, Rodenwaldt, Rodhain and Van den Branden, Clapier and Montpellier, Lacroix and Boutin, with almost completely negative results. Rodhain and Van den Branden state that Brumpt, in 1904, found them very rarely, that Rodenwaldt found them once among many negative

examinations, and that Ouzilleau found them once only in two thousand examinations. Simon (*loc. cit.*) found that if he squeezed the finger powerfully in making blood smears, larvae of *O. volvulus* were present, and suggested that they were in the lymph that exuded as a result of the squeezing of the tissues.

The following observations were made on prisoners at Seccondee, Gold Coast. An inspection of two hundred and ninety men was made in order to note the presence of subcutaneous tumours and also of abnormal conditions of the skin, especially a dry, glistening, wrinkled appearance, with exaggeration of the normal pattern of lines and intervening areas, the condition termed lichenification. Elephantiasis and pronounced thickening of the skin, 'craw-craw' and signs of scratching were also noted. The results are shown in Table I; in the table, L. = lichenification, E. = elephantiasis, T. = thickening of the skin approaching elephantiasis in degree but not specially localised, C.-C. = craw-craw.

TABLE I.

Number examined	Subcutaneous tumours present	Abnormal Skin Conditions				
		L.	E.	T.	C-C.	Scratches present
290	16	24	1	3	5	20

Twenty-four cases were selected for investigation; of these thirteen had subcutaneous tumours, and in fifteen the skin showed lichenification. Three of the five cases of craw-craw, the three cases of greatly thickened skin, and the single case of definite elephantiasis of the external genital organs, were also included.

METHOD OF EXAMINATION FOR LARVAE IN THE SKIN

A piece of skin about half a square centimetre in area was excised from the left lower dorsal region in each case and put into a small tube containing normal (0·85 per cent.) salt solution. A bit of the skin was teased and examined soon after excision, the rest being left in the salt solution for a few hours to allow some of the larvae to escape from the skin. The piece of skin was then removed

from the salt solution to 70 per cent. alcohol for subsequent section. The whole of the deposit that formed at the bottom of the tube was put on a slide and examined for the presence of larvae, then fixed by the addition of two or three drops of Ruge's solution (formalin 2 per cent. containing 1 per cent. acetic acid), dried and stained with warm haemalum solution. Drawings and measurements of the larvae were made with the aid of a camera lucida. The chief clinical features and the results of the examination are summarised in Table II, which shows the occurrence in association of subcutaneous tumours, various clinical skin conditions and the larvae of *O. volvulus* in the skin. The same letters as in Table I are used to denote the skin condition.

TABLE II.

Number of cases	Tumours present	Skin Condition						Larvae of *O. volvulus* in skin
		Normal	L.	L. & E.	L. & C-C.	T.	C-C.	
7	7	...	4	...	2	1	...	7
3	3	3	...	...	...	...	...	3
5	...	...	1	1	...	2	1	5
1	1*	...	1	...	...	...	...	...
2	2†	2	...	...	...	...	...	...
6	...	...	6	...	...	...	...	...
24	13	5	12	1	2	3	1	15

* Aspiration of the tumour failed to show larvae of *O. volvulus*.

† Tumours excised and found not to contain *O. volvulus*.

EXAMINATION OF THE BLOOD

In each case a thick blood smear was taken from the finger both by day and by night. In fourteen of the cases a more thorough examination was also made; six or more fresh blood preparations from the finger and from the back near the place from which the excised piece of skin had been taken were examined. The skin was strongly squeezed also in order to see whether larvae of *O. volvulus* would be readily squeezed out in this way in cases where they were

known to be present in the skin. In three cases about 3 cubic centimetres of blood were withdrawn from a vein and centrifuged, and the deposit examined. Larvae of *O. volvulus* were found in one case only, Case 6, in blood from the skin of the back. The skin in this case was heavily infected, the excised piece yielding about eight hundred larvae to the saline solution in which it was put. This case was one of the three whose blood was centrifuged. In the three cases with greatly thickened skin, and in the case of elephantiasis, thick smears of blood were taken at night from the finger. Embryos of *Filaria bancrofti*, Cobbold (1877), were found in the case of elephantiasis. In the course of the examinations of the blood and of the excised pieces of skin, larvae closely resembling and probably identical with that of *Acanthocheilonema perstans* (Manson), 1891, were seen in twelve cases, and embryos of *F. bancrofti* in three cases.

VITALITY OF LARVAE OF *O. VOLVULUS*

(*a*) *In normal* (0·85 *per cent.*) *salt solution.* The larvae deposited in the tubes of salt solution, when examined a few hours after excision of the pieces of skin, were living and showed active movement. In cover-glass preparations of teased skin, kept in a moist chamber at room temperature (about 25° C.), the larvae were seen to be alive eight hours after removal from the body; on the following day all were motionless. In a case not included in this series, actively moving larvae of *O. volvulus* were found in the skin twenty-two hours after the death of the patient from pulmonary tuberculosis. Larvae obtained by aspiration of a tumour in Case 24 and mounted in salt solution under a cover-glass, ringed with vaseline, showed movements for forty-eight hours.

(*b*) *In blood.* A drop of blood from the skin of the back of Case 6, containing a few larvae of *O. volvulus*, was covered and ringed with vaseline and kept in a moist chamber at room temperature (25° C.). The larvae showed fairly active movement for over five days. Staining subsequently with haemalum confirmed the identity of the larvae. It is interesting to note that Robles (1919) found that the larvae of *Onchocerca caecutiens*, Brumpt, 1919, rapidly died in blood.

IDENTITY OF THE LARVAE IN THE SKIN WITH THE LARVAE OF *O. VOLVULUS*

(*a*) *Morphology*. In the few measurements made of living larvae from the skin, the length varied from 290 to 340μ, the breadth from 6 to 7μ. Stained prepartions showed that they were sheathless, with the cuticle transversely striated for the whole length. The anterior end was free of nuclei for a distance usually of about 10μ; the posterior end was sharply pointed, curved generally at a wide angle, and was free of nuclei for usually the terminal 12 to 15μ. The nuclei were small, mostly oval, longitudinally arranged and closely crowded together, the terminal one being usually distinctly elongated. Of the fixed points of Fülleborn's scheme, the 'nerve ring' and last nucleus were the most easily seen and measured. The G1 cell could not be definitely distinguished in many specimens; in those measured the most frequent position was between 69 and 70 per cent. of the length from the anterior end. Some of these features are shown in Table III, and Tables IV and V give comparative measurements of larvae from tumours.

TABLE III.

Films from the deposit in the tubes containing pieces of skin in salt solution; measurements of 168 specimens, 12 from each of 14 cases.

Length		Relative position of 'nerve ring'		Relative position of last nucleus	
Microns	Number	Percentage	Number	Percentages	Number
235	3	21	3	92·5	2
250	16	22	26	93·5	11
265	46	23	82	94·5	72
280	66	24	52	95·5	78
295	26	25	5	96·5	5

Anterior end free from nuclei		Posterior end free from nuclei	
Microns	Number	Microns	Number
6–8	16	7–11	30
9–12	148	12–16	133
13–16	4	17–21	5

TABLE IV.

Measurements of 50 larvae from a tumour excised from Case 22.

Length		Relative position of 'nerve ring'		Relative position of last nucleus	
Microns	Number	Percentage	Number	Percentage	Number
225	6	21	1	92·5	1
235	19	22	9	93·5	5
250	17	23	20	94·5	35
265	5	24	15	95·5	8
280	1	25	2	96·5	1
295	1	26	1	...	...
310	...	27–29	...	...	...
325	1	30	1	...	...
...	...	31	...	...	...
...	...	32	1	...	...

Anterior end free from nuclei		Posterior end free from nuclei	
Microns	Number	Microns	Number
6– 7	10	8–10	9
8– 9	32	11–13	30
10–11	8	14–17	11

TABLE V.

Measurements of 40 larvae from fluid obtained by aspiration of tumours in Cases 2 and 7, 20 from each.

Relative position of 'nerve ring'		Relative position of last nucleus	
Percentage	Number	Percentage	Number
21	1	93·5	10
22	6	94·5	22
23	17	95·5	8
24	13	...	...
25	3	...	...

(*b*) *Relationship to tumours.* In Table II it is seen that larvae were found in the skin in ten of the thirteen cases with subcutaneous tumours. Of the three cases where tumours were present and larvae of *O. volvulus* were not found in the skin, tumours were excised in two and found not to contain *O. volvulus*; in the third case aspiration of the tumour failed to show the presence of larvae. Hence larvae of *O. volvulus* were present in the skin in at least 90 per cent., and possibly in all of the cases with subcutaneous tumours which might be tumours of *O. volvulus*. By excision in Case 22 and by aspiration in Cases 2, 6, 7 and 24, the tumours were shown to contain *O. volvulus*; in these cases larvae were found in the skin. In five cases larvae were present in the skin, but no tumours could be found.

These results confirm the observations of Montpellier and Lacroix and of Ouzilleau, Laigret and Lefrou, that the larvae found in the skin are larvae of *O. volvulus*.

SECTIONS OF SKIN

Larvae of *O. volvulus* were seen in sections of the skin in the papillary and sub-papillary layers at all levels. In many sections they could be clearly seen to be quite apart from the blood vessels. No very marked changes in the skin were observed; there was an excess of cells in the papillary layer and around the capillaries. Otherwise the sections appeared to show little departure from normal.

THE SKIN CONDITIONS AND THEIR RELATIONSHIP TO THE LARVAE

Lichenification was most evident on the back, buttocks and posterior aspect of the thighs; the shoulders and arms were less affected, the chest and abdomen usually still less, and the face, throat and limb flexures hardly at all (Plates XVII and XVIII).

Sweating of the skin was tested in six of the cases; they were set to do hard work in the sun for a few minutes, and in each case sweating of the affected areas was observed.

Itching does not appear to have been severe in most of the cases. One man whose back showed pronounced wrinkling of the skin,

maintained that there was no itching and his skin showed no marks of scratching, yet the excised piece of skin yielded about five hundred larvae to the salt solution in which it was placed.

The number of larvae counted in the smears of the deposit in the tubes of salt solution varied greatly, the greatest number being seven hundred and eighty-five and the smallest two. In Cases 1 and 12 (Plates XVII and XVIII) the numbers were respectively one hundred and seventy-two and five hundred and forty-three. No relationship between these numbers and the degree of skin affection was established. There were six cases with well marked lichenification in whom the excised piece of skin showed no larvae of *O. volvulus.* On the other hand, in three cases with larvae in the skin the latter presented a normal appearance. Larvae were present in the skin in the three cases of 'craw-craw,' and in the four cases with greatly thickened skin, including the case of definite elephantiasis.

In these various conditions there appears to be nothing to indicate a connection between the presence of the larvae of *O. volvulus* in the skin and the appearances observed.

CONCLUSIONS

The following conclusions are drawn:—

1. The larvae in the skin were those of *O. volvulus.*

2. They are present in the skin in all, or nearly all, cases with tumours of *O. volvulus.*

3. No clear causal relationship between the larvae and the conditions of 'craw-craw,' elephantiasis and lichenification was shown in these cases.

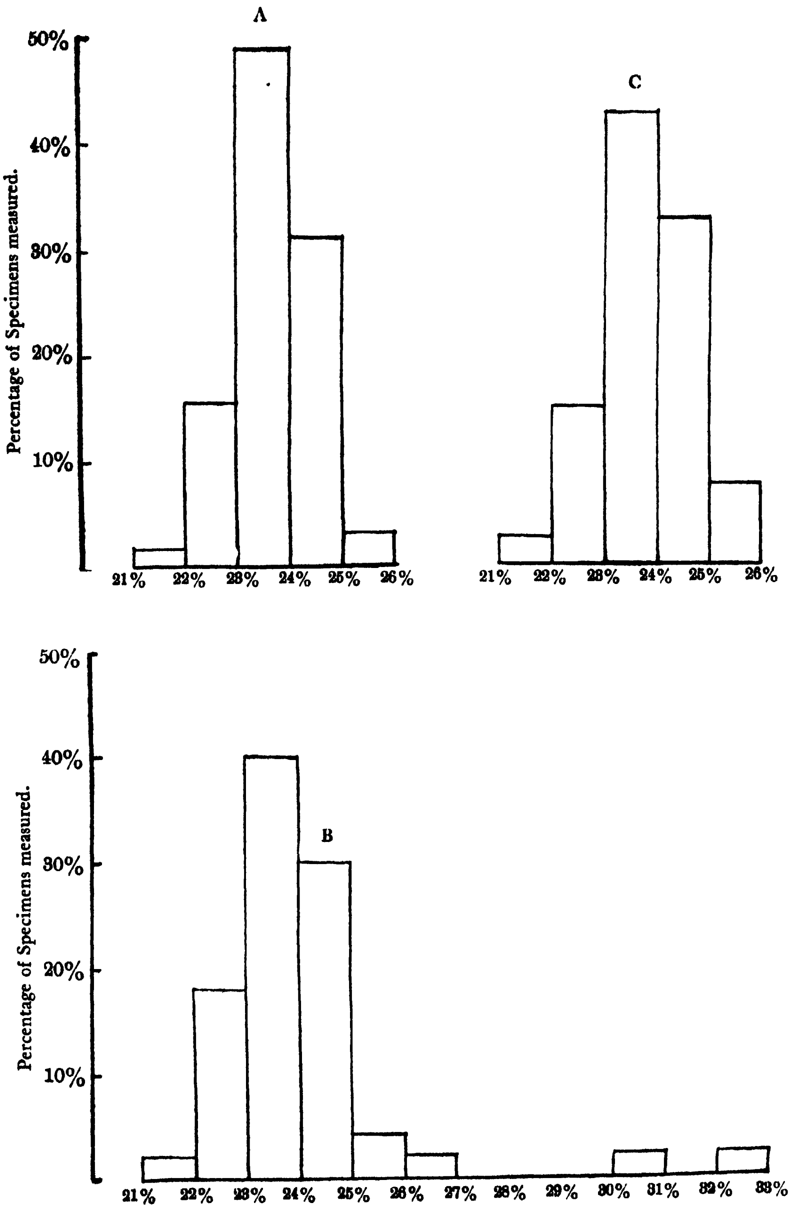

FIG. 1. Comparison of relative position of 'nerve ring' in larvae from (A) skin, (B) excised tumour, and (C) fluid aspirated from tumours; from Tables III, IV and V respectively.

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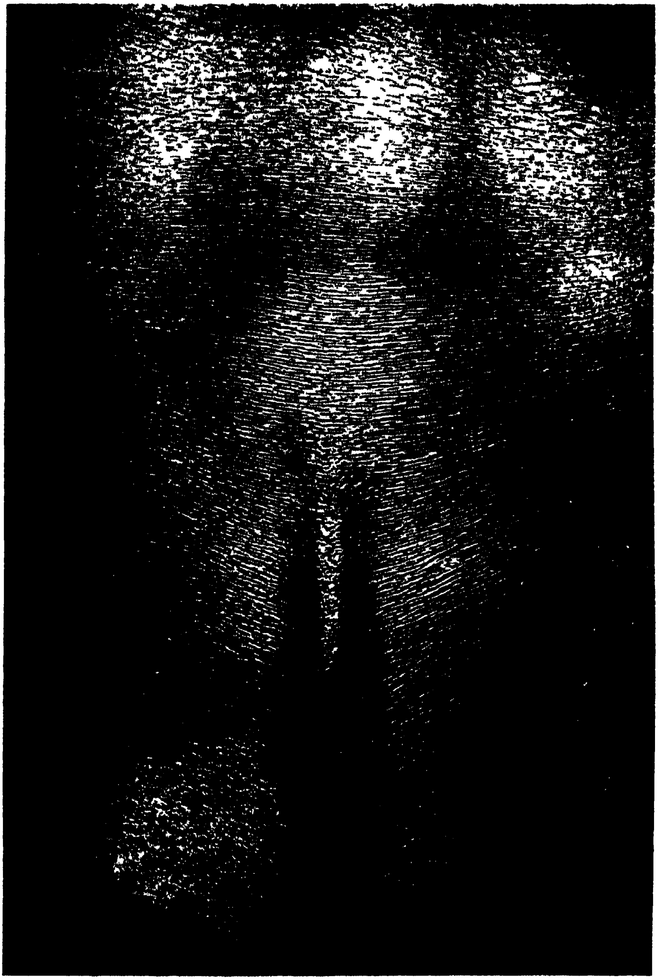
EXPLANATION OF PLATE XVII

Case 1. Portion of back, showing lichenification of the skin. Three small tumours were present: one behind the great trochanter and two over the lumbar vertebral spines. Larvae of *O. volvulus* were present in the skin.



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EXPLANATION OF PLATE XVIII

Case 12. Showing lichenification of the skin. No tumours were found. Larvae of *O. volvulus* were present in the skin. This case had elephantiasis of the external genital organs; the blood contained embryos of *F. bancrofti* and of *A. perstans*.

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A CASE OF SLEEPING SICKNESS (*T. GAMBIENSE*) TREATED BY 'BAYER 205'

BY

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AND

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(*Received for publication* 20 *November*, 1922)

H.L.S. *Aet.* 25.

No history of having been bitten by a tsetse fly, but in August, 1921, was for 2½ days in a tsetse belt at Wamba, South of Jemaa, N. Nigeria.

21.11.21. Took to bed with fever at Jemaa. Ill for 8 days, then recovered somewhat, but still unwell and had aching in legs.

—.1.22. Glands in neck found to be enlarged, and a blood film was reported to contain trypanosomes. Was sent home.

9.3.22. On examination at the Liverpool School of Tropical Medicine the condition was as follows:—

Lymphatic glands behind the sterno-mastoid on both sides as large as marbles; axillary glands about the same size; inguinal glands (?) enlarged. A circinate rash over the back; over a V-shaped area on the chest, corresponding to the opening in the shirt, deep erythema, with some indication of pitting, probably due to sunburn. Pulse 112. Spleen not enlarged.

Blood examination.

Fresh films negative. Centrifuged blood, trypanosomes found, 1 to 10 fields.

Gland puncture.

A few trypanosomes found.

Animal inoculations.

1. Of 2 mice inoculated intraperitoneally with 0·4 c.c. of citrated blood, one became infected 29.3.22 and died 22.9.22; the other did not become infected.

2. A mouse inoculated intraperitonealy with a suspension of trypanosomes obtained by centrifuging 10 c.c. of the patient's blood showed trypanosomes 17.3.22. The animal is still alive and infected 6.11.22.

3. Various other mice were sub-inoculated from these and became infected. Most of the animals are still alive after six months, and occasionally show trypanosomes in their blood.

4. The trypanosome shows the morphological characters of *T. gambiense*.

Treatment.

10.3.22. *Atoxyl*, 0·45 gramme, subcutaneously.
13.3.22. *Atoxyl*, 0·45 gramme, subcutaneously.
17.3.22. *Novarsenobillon*, 0·6 gramme, intravenously.
20.3.22. Glands smaller, one on right side as big as large pea. Weight, 124 lbs.
20.3.22. *Novarsenobillon*, 0·9 gramme intravenously.
23.3.22. Patient ill, temperature 103°, blood negative.
27.3.22. Patient better, blood negative, auto-agglutination distinct.
1.4.22. Patient feels well, glands greatly decreased, blood negative, very little auto-agglutination. Weight, 125½ lbs.
8.4.22. Glands hardly palpable, pulse 130, blood negative.
12.4.22. Pulse 108, blood negative, auto-agglutination distinct. Weight, 124 lbs.
18.4.22. Pulse 112, blood negative. Weight, 126½ lbs.
24.4.22. Glands doubtfully palpable, blood negative. Weight, 127¾ lbs.
29.4.22. Pulse 120, blood negative. Weight, 132 lbs.
6.5.22. Pulse 96, blood negative. Weight, 136½ lbs.
14.5.22. Temperature 103°, blood negative. Weight, 137 lbs.
19.5.22. Temperature 100°.
26.5.22. Thick blood film negative. Weight, 137 lbs.
27.5.22. Temperature 99°.
28.5.22. Temperature 101·2°. Thick blood film (stained). 2 trypanosomes found.
30.5.22. Temperature normal. '*Bayer* 205,' 0·5 gramme intravenously. Patient vomited a minute or two after the injection.
31.5.22. Temperature subnormal. Pulse 96. Urine no albumen.

1.6.22. Temperature subnormal. Pulse 78. '*Bayer* 205,' 1·0 gramme intravenously.

3.6.22. Temperature subnormal. Pulse 92, a macular rash external to each mamma. '*Bayer* 205,' 1·5 gramme intravenously.

8.6.22. Urine slightly turbid, no albumen.

27.6.22. Temperature normal. Urine slightly turbid, no albumen. '*Bayer* 205,' 1·0 gramme intravenously.

20.11.22. Patient states that he has remained quite well without any rise of temperature since 27.6.22. Weight, 142 lbs. On examination: an acne-like rash over the back and sternum. Glands in neck not enlarged, but some just appreciable to palpation. Pulse 84-86, a little irregular. Respirations 17. Urine, no albumen. Centrifuged blood (5 c.c.) negative microscopically.

SUMMARY

The patient was presumably infected in Northern Nigeria in August, 1921, and had no treatment prior to his arrival in England in March, 1922, although trypanosomes had been found in his blood in January. When first seen in Liverpool on 9 March, trypanosomes were found both in the blood and gland juice. He was given subcutaneous injections of 0·45 gramme Atoxyl on 10 and 13 March, and intravenous injections of Novarsenobillon 0·6 gramme and 0·9 gramme on 17 and 20 March, respectively. These injections were attended by considerable rises of temperature which lasted up to 23 March.

As a result of this treatment the general condition of the patient rapidly improved, the rashes disappeared, the enlargement of the lymphatic glands almost completely subsided, the weight steadily increased, and trypanosomes could no longer be found in the blood. The pulse, however, remained frequent. Except for two rises to 100° F. on 27 March and 9 April, the temperature remained normal until 14 May, when it rose to 103° F. Frequent examinations of the blood during this period were negative. On 28 May the temperature rose to 101·2° F., and trypanosomes were found in the blood. On 30 May an intravenous injection of 'Bayer 205,' 0·5 gramme was given, a second injection of 1 gramme on 1 June and a third of 1·5 gramme on 3 June: the temperature fell to normal after the

first injection, and has since remained normal. The blood was negative on 31 May and also on 3, 8, and 27 June, and the general condition of the patient remained good. No albuminuria developed. On 27 June an intravenous injection of 'Bayer 205,' 1 gramme was given as a 'prophylactic' measure, and since then he has remained in good health.

We are indebted to Messrs. Friedr. Bayer & Co., Elberfeld, for kindly supplying us with a quantity of 'Bayer 205.'

Note.

In a previous paper by Yorke (1921), details are given of the treatment by 'Bayer 205' in July, 1921, of a case of Rhodesian sleeping sickness. The patient, who is now back in Rhodesia, has remained in excellent health up to the present time.

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NOTES ON THE BIONOMICS OF *STEGOMYIA CALOPUS*, MEIGEN, IN BRAZIL

PART II

BY

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(*Received for publication* 9 *November*, 1922)

THE ABSENCE OF *STEGOMYIA CALOPUS* LARVAE FROM NATURAL WATERS

From December, 1920, to February, 1922, a fairly extensive search was made in the town of Manáos, its native suburbs, and the sparsely inhabited forest surrounding it, for the breeding-places of various mosquitoes. During this examination *Stegomyia calopus* larvae were never found, except in domestic waters in the immediate vicinity of a human habitation. Young (1921), writing from Manáos, has drawn attention to the same point; Howard, Dyar and Knab (1912) state: 'The larvae are found practically exclusively in artificial receptacles about human habitations. It may be said that the larvae of *calopus* are never found in swamps, in pools or in temporary puddles, even when these are in close proximity to houses.'

The three experiments that follow were devised to test whether the absence of larvae from such waters was due to the disinclination of females to oviposit in them, or to the inability of the larvae to develop when placed there.

Some small stagnant pools situated on the outskirts of the town, about fifty yards from six native houses and about the same distance from the tram line, were selected for the experiments; water from pools of this description will be referred to in the text as 'natural water,' in

contra-distinction to the term 'domestic water' as applied to water in rain barrels, water troughs, etc.

Experiment I. A varying number (4 to 11) of *S. calopus* females were confined in two breeding cages, and in each cage were placed six large watch glasses containing water from various sources, both natural and domestic; the position of these glasses was constantly varied to prevent any undue influence of light or shade. Males were introduced and the supply kept constant. Sugar solution was supplied for the males; the females were fed on human blood, a feed being usually offered every other day. The resultant eggs were removed and counted every twenty-four hours. The experiment was continued for five weeks, with the results recorded below.

TABLE I.

	Nature of water supplied	Total number of eggs deposited	Percentage deposited in each type of water
1	Distilled water	146	9·6
2	Barrel water in which wild *Stegomyia* were freely breeding	88	5·8
3	Water from a small pool on the outskirts of the town; this pool harboured *Culex* and dragon-fly larvae ...	149	9·8
4	Deep pool near (3); contained *Culex* but no dragon-fly larvae	309	20·4
5	Same as (4), but algae added	728	48·1
6	Small pool, same source as (3) and (4). *Culex* and dragon-fly larvae, but no vegetation	92	6·0

CONCLUSION. *Stegomyia* in captivity will oviposit as readily in natural as domestic waters. This conclusion agrees with that of Bacot (1916), and of Fielding (1919), but both these authors used domestic water throughout their experiments, and to this added various organic substances.

Experiment II. To ascertain whether *Stegomyia* ova and larvae can develop in natural waters, when these have been cleared of inhabitants inimical to the life of the larvae. Eight jars were used; six of these contained 400 c.c. of water and two 800 c.c, all the waters being carefully strained through fine wire gauze, before the introduction of the larvae.

TABLE II.

No. of Jar	Nature of the water used	No. of Ova added	No. of larvae which hatched	No. of Imagoes	Percentage of Ova which completed cycle	Average time taken to complete cycle
						days
1	Tap water, plus 2 grs. of rice ...	24	23	8	33	28
2	Water from a barrel in which *Stegomyia* were freely breeding ...	24	24	10	41	24
3	Small pool natural water which contained dragon-fly and water-beetle larvae	30	21	3	10	22
4	Small pool natural water which contained no insect life	30	26	25	83	21
5	Tap water plus 2 grs. of rice ...	30	22	3	10	37
6	Small pool natural water which contained dragon-fly and *Culex* larvae	30	25	23	70	25
7	800 c.c. water as in Jar 2	30	28	11	36	17
8	800 c.c. water as in Jar 3, plus well-washed duck weed	30	?	13	43	10

CONCLUSION. *Stegomyia* ova hatch and the larvae develop freely in natural waters after these have been freed from insects inimical to their development.

Experiment III. To ascertain whether *Stegomyia* larvae can develop in pools of natural water when (1) unprotected from their insect enemies, (2) protected from their insect enemies.

A small pool such as is described under Experiment I was selected. A careful netting of the pool showed the following inhabitants :—dragon-fly larvae, tadpoles, a few water bugs (*Zaitha* sp.), a small water beetle (previously shown to be harmless to mosquito larvae). No culicidae larvae were found, though the neighbouring pools showed large numbers, mostly *Culex fatigans*.

Into this pool were introduced 900 dried eggs and a few fresh eggs of *Stegomia calopus* (average fertility of dried eggs was found to be about 40 per cent.), also 300 larvae of *Stegomyia* and 200 larvae of *C. fatigans*, the larvae being on an average 48 hours old. Two glass cylinders,

arranged as shown in fig. 1, were fixed to pointed sticks and these sunk into the mud at the bottom of the pool, about three inches of the cylinder being left projecting above the surface of the water. Into one tube were introduced 50 dried eggs, and 24 fresh eggs of *Stegomyia*. Into the other were placed 20 *C. fatigans* larvae (not more than 24 hours old) During

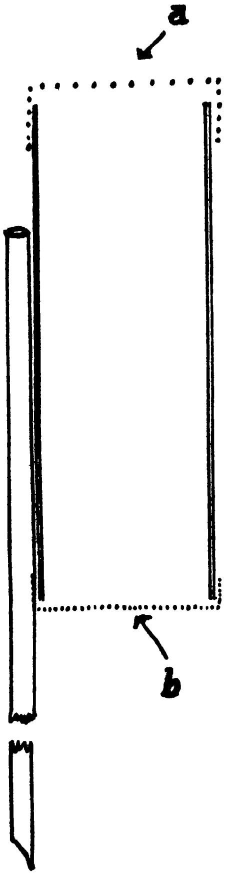

FIG. 1

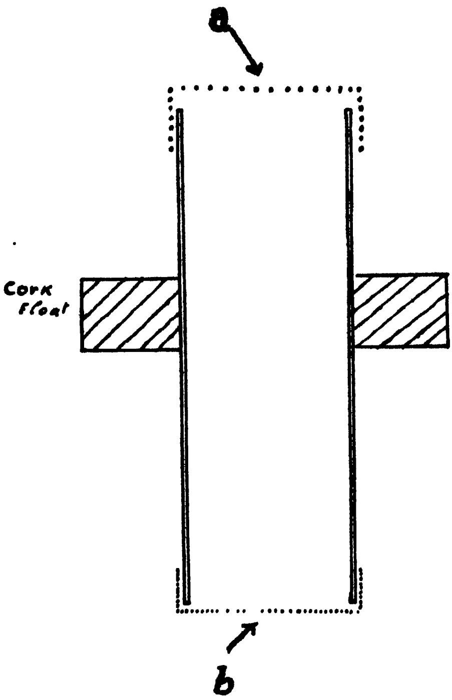

FIG. 2

FIGS. 1 and 2. Glass cylinders, 8 in. × 2 in., used in Experiment III.
(*a* = Mosquito-proof gauze; *b* = Fine wire gauze.)

the course of the next seven days the pool was regularly visited, but, unfortunately, a week's heavy rain interfered with the observations and the experiment was brought to a close on the eighth day by the rising water in the pool completely submerging the tubes.

The following results were obtained. In spite of very careful searching no *Stegomyia* larvae were found in the pool during the eight days it was kept under observation, the first search being made twenty-four hours after the introduction of the ova and larvae; *C. fatigans* were present during the whole experiment, although on two occasions no larvae could be found; this was probably due to the muddy condition of the water. Of the larvae in the guarded cylinders, both lots appeared to be doing well, three *Stegomyia* imagoes emerging during the eight days; many of the *C. fatigans* larvae reached the fourth stage, but none pupated.

A few months later the experiment was repeated with the following modifications:—600 *calopus* and 255 *fatigans* larvae at all stages of development were added to the pool, and in the cylinders were placed respectively, 26 *calopus* ova (average fertility of a sample found to be 90 per cent.) and 26 *fatigans* ova (average fertility 100 per cent). In lieu of fixing the cylinders to sticks they were attached to cork floats (fig. 2) and allowed to float clear in the pool. The results obtained were precisely similar to those in the previous experiment, except that no imagoes were obtained though both tubes contained apparently healthy larvae. As before, *calopus* larvae disappeared after the first twenty-four hours, while *fatigans* persisted. The observations were brought to a close on the seventh day by the drying of the pool.

SUMMARY. *Stegomyia calopus* ova and larvae, introduced into a natural pool infested with insect enemies, disappeared after the first twenty-four hours, whereas *Culex fatigans* larvae, added under the same conditions, persisted for at least eight days. *S. calopus* ova placed in the same pool, but under conditions protecting them from insect enemies, developed and produced imagoes.

ORDER OF HATCHING OF MALES AND FEMALES

Rees (1901) states: 'When mosquitoes are bred in captivity the males as a rule hatch out first, and in greater numbers than the females.' Nuttall and Shipley (1901) comment on this statement as follows:— 'We have found no similar statement elsewhere, and the observations we have made do not tend to confirm his observation. The proportion of males to females has always appeared to us to be fairly equal, and we have counted the sexes on several occasions.' Bacot's (1916) observations in West Africa would appear to confirm Rees. Writing of *Stegomyia* he says:

'. . . the early males being usually a day quicker in their development than the females.'

The following note deals only with the order of hatching, Young (1922) having already dealt with the proportion of males to females. As it appeared possible that the food supply might influence the sexes differently, an attempt was made to breed the larvae on different food supplies, other factors being kept as nearly as possible equal. To do this, mixed batches of eggs were sunk and the larvae within twelve hours of hatching transferred to jars containing one of the following two food supplies:—(1) Minimum food supply, viz., tap water to which was added 0·015 per cent. polished rice and 0·5 grm. well-washed duck-weed to each 300 c.c.'s. water. (2) Maximum food supply, viz., stagnant river water filtered through fine wire gauze, to which was added 0·018 per cent. Peptone (Fairchild) and 0·5 grm. well-washed duck-weed to every 300 c.c. of water. Each larva was allowed 30 c.c. of the prepared water, this amount being regulated every day; thus to start with, ten larvae were placed in 300 c.c. of the food supply; if two died within twenty-four hours then the amount of water was reduced to 240 c.c. and so on. The results are shown in the following tables:—

TABLE III.

Maximum food supply. Number of larvae = 270.

Day of emergence ...	5	6	7	8	9	10	11	12	13	14	15	Total
Males	0	3	33	58	20	25	3	0	0	0	0	142
Females	0	1	10	35	24	24	3	1	0	0	0	98

TABLE IV.

Minimum food supply. Number of larvae = 305.

Day of emergence	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Males ...	0	5	17	19	9	10	11	6	9	9	5	2	0	0	0	0	1	1	0	1	0
Females ...	0	0	1	8	10	8	18	11	14	10	7	3	4	3	0	1	1	0	2	0	0

SUMMARY. In a mixed batch of ova, hatched and allowed to develop under food conditions which were either (1) favourable, or (2) adverse to growth, it was found that a much greater number of males than females reached maturity during the first few days of the emergences. This preponderance of males was greater than could be explained by the higher proportion of males to females (142 to 98, and 105 to 101) as observed in the completed experiments.

OVULATION

Experiment I. Results of Diets other than Blood.

Goeldi (1905), in Brazil, after numerous experiments with fruit, sugar, honey, etc., came to the conclusion that blood was necessary for the production of eggs by *Stegomyia calopus.* Fielding (1919), working in Australia with the same species of mosquito, obtained fertile eggs on three occasions on which peptone and sugar was given as a food. Ken (1917), in India, fed *Stegomyia scutellaris* on sugar, milk and sugar, peptone and sugar, with positive results.

S. calopus females were kept under observation for a period of over twelve months, at least twenty being always present in the cages. During this time the ordinary food supplied was sugar and water, and on two occasions a mixture of sugar and peptone was given for several days; the results were similar to those already published by Young (1922), no instance of egg laying being recorded.

Several authors record mosquitoes feeding on plants; thus Theobald (1901), states: 'I have frequently seen Culicidae settled on Compositae sucking the juices of the flowers, both males and females,' and Giles (1902), states: 'When mosquitoes are unable or unwilling to obtain blood they suck the juices of plants.' Knab (1907), quotes other instances. The following two experiments were made to see whether *Stegomyia* would feed on flowering plants, and if so, whether ova would result.

(1) Thirteen females were confined for thirty-eight days in a cage and supplied with water and a variety of flowering plants, representing as nearly as possible all the species growing within a ten-yards' radius of a heavily infected breeding place (a disused water barrel); in all seventeen species of plants were used, and each plant was allowed to remain in the cage for three to four days. In addition to the plants the fruits 'Goiaba' and banana were supplied. Males were always kept present. Both males and females constantly alighted on the flowers, inserted their proboscis in the corolla, and apparently absorbed some fluid.

(2) Seven females were observed under the same conditions for twenty-one days, but the following additional fruits were used: Melon, 'Mammão,' Mango, Orange, 'Periba,' 'Caju,' the results being the same as in the first experiment.

A trial was then made of the following native fruits: (3) Three females fed for thirteen days on Mango, 'Mammão,' Melon, Orange, Banana. (4) Five females fed for thirteen days on Mango, Orange, Banana, 'Periba,' 'Mammão.' No eggs were laid in either of the latter experiments.

SUMMARY. Female *Stegomyia* were offered and fed readily on sugar, sugar and peptone, flowering plants, and various fruits. No eggs were laid after feeding on any of the above substances.

Experiment II. Results of feeding on animals and birds with special reference to Bats and Wall Geckos.

Durham (1902), MacGregor (1915), Bacot (1916), Theobald (1916), and Fielding (1919), record *Stegomyia* feeding on Dog, Goat, Rat, Bandicoot, Agouti, and Guinea Pig; the results of the author's experiments of feeding *S. calopus* on various animals and birds are recorded in the following table.

TABLE V.

No.	Animal or bird used and method of feeding adopted.	Whether seen to feed	Ova laid	Whether fertile
1	A small finch confined in mosquito cage day and night on eight occasions	No	o	—
2	A rock-dove confined in mosquito cage day and night on four occasions	No	o	—
3	Young parrots; the tube containing the mosquitoes was applied to the host's body	Yes	+	+
4	Domestic chickens; method of feeding as above	Yes	+	+
5	A young otter; method of feeding as above. (Only a little blood absorbed, partly due to restlessness of animal) ...	Yes	o	—
6	Lesser Ant Bear; method of feeding as above. (Only half-hearted attempts made to pierce the skin)	No	o	—
7	Monkey; method of feeding as above	Yes	+	+
8	Cotia; method of feeding as above	Yes	+	+
9	Young Iguana (*Urocentron azureum*) confined in mosquito cage for some days and nights	No	o	—
10	Young Wall Gecko, placed loose in cage and also enclosed in tight fitting gauze bag; several trials day and night ...	No	o	—
11	Bats (*Molossus obscurus*) left loose in cage; several experiments tried both day and night	Yes	+	+

The above list requires no comment, except for the last two animals named. In all houses observed in Amazonas, whether deserted or occupied, two animals were constantly found present, viz., the gecko and various species of bats. Special attention was, therefore, devoted to seeing if *Stegomyia* would feed on these in the absence of human blood. The experiments with the gecko were frequently repeated, using both young and adult specimens. At first it was allowed loose in a cage of hungry mosquitoes, none of which attempted to bite. The gecko destroyed numbers of the mosquitoes, so in subsequent observations it was enclosed in a tight-fitting gauze bag and placed on the bottom of the cage. Though mosquitoes were often seen to alight on the gauze and probe it tentatively, they were never seen to draw blood, nor were any females gorged in the morning if the gecko and bag were allowed to remain in the cage over night.

The only record noted of mosquitoes feeding on bats is that of Durham (1902) at Pará, who observed a *Stegomyia calopus* female feed on 'a small bat (Phyllostoma).' The following species of bats were found to be common in or around houses in Manáos : *Saccopteryx bilineata*, Tenum., *Hemiderma perspicillatum*, L., *Vampyrops zarhinus*, H. All., *Molossus rufus*, Geoff., *Uroderma bilobatum*, Pet., *Molossus obscurus*, Geoff. Of these *Molossus obscurus* appeared to be the commonest in houses, and was used in the following three feeding tests. (1) Eleven offered a feed and nine fed ; (2) three offered, two fed ; (3) six offered, six fed. Not only did a far higher percentage of those given the opportunity feed on bats than on other animals, but they appeared to attack their host with a far greater voracity than they were observed to exhibit towards any other creature except man. They usually settled on and pierced the wing membranes, and as soon as they were flicked away returned to the attack, the complete feed being thus performed in a series of interrupted bites.

CONCLUSION. *Stegomyia calopus* feeds with great readiness and voracity on bats ; it appears likely that these serve as important food reservoirs in deserted houses, or sparsely inhabited districts. It will also feed, but with less eagerness, on certain other animals and birds. All attempts to induce *Stegomyia* to bite the common wall gecko failed.

Experiment III. Results of feeding on washed red cells, serum, and citrated blood.

Otto and Neumann (1905), in Brazil obtained fertile eggs by feeding *Stegomyia* on blood and salt solution. Bacot (1916), in West Africa, on

two occasions obtained single eggs by feeding the mosquitoes, on one occasion on honey and blood, and on the other on syrup and blood, one of these eggs proving fertile. Marchoux and Simond (1906), at Rio imprisoned eight female *Stegomyia* and fed them as follows: Two on fresh human

TABLE VI.

No.	No. of female *Stegomyiae*	No. of days observed	Food: and how offered	No. of Ova laid
1	6	15	Washed sheep's cells in normal saline. 0·5 c.c. in a watch-glass	0
2	5	17	Washed sheep's cells in normal saline. 0·5 c.c. in a watch-glass	0
3	7	19	Sheep's serum. 0·5 c.c. in a watch-glass	0
4	7	24	Washed human red cells in normal saline. 0·5 c.c. in a watch-glass	0
4a	3	9	Washed human red cells in normal saline in tubes; same mosquitoes as in (4)	0
5	6	26	Human serum. 0·5 c.c. in a watch-glass	0
5a	3	5	Human serum, in tubes; same mosquitoes as in (5) ...	0
6	6	29	Whole human blood in saline. 0·5 c.c. in a watch-glass ...	0
6a	3	8	Whole human blood in tubes with normal saline; same mosquitoes as in (6)	0
7	3	10	Cotton ball soaked in whole human blood plus normal saline, suspended in cage	0
8	3	16	Cotton ball soaked in washed human red cells in normal saline, suspended in cage	0
9	3	13	Cotton ball soaked in human serum suspended in cage ...	0
10	2	14	Cotton ball soaked in washed human red cells plus normal saline, suspended in cage	0
11	3	8	Cotton ball soaked in whole human blood plus normal saline, suspended in cage	30*
12	3	12	Cotton ball soaked in human serum, suspended in cage ...	0

* 29 hatched

serum, two on red cells separated by centrifuging, two on blood-clot, and two, which were used as a control, on themselves. The last two laid eggs, the remainder did not.

In the following experiment males were always present in the cages, and water supplied for the reception of eggs. The food was renewed every two or three days, in some instances every day. In Table VI (p. 434), under the column 'Food,' the expression 'in tubes' refers to the method used by Rodhain and others (1912) for feeding tsetse flies: small segments of glass tubing were covered at one end with the thin skin of a bat, filled with the food to be tested and suspended in the cage. This proved to be a very satisfactory method of feeding; the proboscis of the mosquito could be clearly seen piercing through the membrane into the fluid and sometimes the absorption of food could be observed; but neither by this nor by any other method, were the mosquitoes induced to feed to repletion as they do on the living animal.

SUMMARY. In a series of experiments in which fifty-four females were offered as food either serum, washed red cells, or whole blood (the two latter being diluted with normal saline), it was found that the mosquitoes absorbed any of the fluids offered, but that oviposition only resulted in the case of whole blood.

BITING OF CADAVERS

Rosenau and others (1904) quote two instances of *Stegomyia* feeding on native corpses, respectively half an hour and twelve hours after death. Christy (1900) observed mosquitoes (Anophelines) feeding on a white man's corpse in Nigeria three and a half hours after death.

The mosquitoes mentioned in the following notes were first tried on the living subject, and, if found willing to feed, were given the opportunity of biting the cadaver. All experiments were conducted in day-light.

(1) Native Brazilian, dead three hours. Three females used; all three bit, only one filled with blood.

(2) Native Brazilian, dead six and a half hours. Three females used; two bit, none absorbed blood.

(3) Native Brazilian, dead seven hours. One female used, which bit and absorbed blood.

(4) Native Brazilian, dead eighteen hours. Three females used; all three bit, none absorbed blood.

CONCLUSIONS. *Stegomyia calopus* females will bite corpses as long as eighteen hours after death, and will draw blood as long as six hours after death.

Young (1921) has dealt with the natural enemies of the larval *Stegomyia* and the value of dragon-flies in the destruction of the adults in Amazonas. The following note deals with the enemies encountered in dwelling-houses. Bacot (1916) considers toads, lizards, spiders, ants, scorpions, and possibly young Mantidae to be destroyers of *Stegomyia*. Marchoux and Simond (1906) at Rio found a jumping spider of the genus *Salticus* was a foe of *Stegomyia*, and came to the conclusion that it was probably of some practical importance. Neither of these authors publish any exact data.

In the experiments that follow an attempt was made to estimate the value of the animal as a mosquito destroyer, first by allowing it to feed on mosquitoes only, and then under conditions which gave it a choice between mosquitoes and other food likely to occur in its natural environment. Bats, wall geckos, and a species of jumping spider, were found to be common in all houses in Manáos. With regard to bats, twelve were killed in houses in Manáos; none of these showed any mosquito remains in the gut, nor were any scales found in the faeces.

Experiment I. A small wall gecko, about four and a half inches long was confined in a mosquito cage; the intervals between the feeds varied from a few minutes to several days.

TABLE VII

No.	*S. calopus*				*C. fatigans*				Other insects, Flies, Grasshoppers, etc.			
	At Start	After 4 hours	After 12 hours	After 24 hours	At Start	After 4 hours	After 12 hours	After 24 hours	At Start	After 4 hours	After 12 hours	After 24 hours
1	25	6	1	1	0	—	—	—	0	—	—	—
2	7	—	—	5	1	—	—	0	29	—	—	several
3	6	—	—	1	5	—	—	1	9	—	—	0
4	2	—	—	1	1	—	—	0	15	—	—	7
5	8	—	—	3	2	—	—	0	14	—	—	3
6	2	—	1	—	2	—	2	—	16	—	7	—
7	3	—	—	0	4	—	—	0	22	—	—	13

Experiment II. A jumping spider (Family *Salticidae,* genus *Akela*) which was found to be very common in all houses in Manáos, was confined either in a mosquito cage or in a small glass aquarium. As before, the intervals between feeds varied greatly.

TABLE VIII

No.	*S. calopus*				*C. fatigans*				Other Insects, Flies, Grasshoppers, etc.			
	At Start	After 4 hours	After 12 hours	After 24 hours	At Start	After 4 hours	After 12 hours	After 24 hours	At Start	After 4 hours	After 12 hours	After 24 hours
1	3	o	—	—	o	—	—	—	o	—	-	-
2	16	—	4	o	o	—	—	—	o	—	-	
3	5	o	—	—	o	—	—	—	o	-		
4	15	o	—	—	o	—	—	—	o	—	—	—
5	11	3	—	o	o		-	—	o	-	—	—
6	17	1	o	—	3	—	o	—	o	—	—	—
7	8	3	—	o	o	—	—	—	5	2	—	o
8	o	—	—	—	10	2	—	—	o	—	—	5
9	o	—	—	—	45	—	—	21	6	—	—	3

CONCLUSIONS. Both the wall gecko and a species of jumping spider (genus *Akela*), were found readily to destroy *S. calopus* and *C. fatigans,* and owing to their wide distribution are probably of some importance in limiting the numbers of mosquitoes occurring in human habitations. Their usefulness is, however, limited by the fact that other insects besides mosquitoes form part of their diet. An examination of twelve bats revealed no mosquito remains in the intestines.

STEGOMYIA CALOPUS BREEDING NATURALLY ON BOARD A SHIP VOYAGING FROM MANÁOS TO LIVERPOOL

Marchoux and Simond (1906) record placing 20 male and 20 female *S. calopus* in breeding tubes when leaving Rio in February, and on arrival at France, in May, twelve females and nine males were still alive. The insects during the voyage were fed on human blood.

The following observations were made in the month of February. Two days after leaving Pará a considerable number of *Stegomyia* were still to be found in various parts of the ship, and as their numbers appeared to be increasing, the whole ship was searched for possible breeding places. Eventually several hundred larvae were found in each of two large glass vases in the passengers' smoke room, both the jars containing cut-palm leaves which had been taken on board at Manáos. The larvae when found were at least forty-eight hours old, and as the steward stated that the vases had been cleaned and refilled about seven days previously, the ova must have been deposited shortly after leaving Manáos. When Havre was reached, sixteen days after leaving Pará, one jar contained many living imagoes, pupae, and larvae, the other, imagoes only. Liverpool was reached twenty days after leaving Pará, and twenty-four hours after the vessel had reached port, numerous living *Stegomyia* adults, both males and females, were present in both jars; in addition one of the jars contained a number of active pupae. The morning (2.0 a.m.) deck temperature varied between 81° F. at Pará and 53° F. in Liverpool.

CONCLUSION. *Stegomyia calopus* is capable of completing its cycle on board a ship travelling between Manáos and Liverpool, and the resultant adults can remain alive until arrival in Liverpool.

NATIVE MOSQUITO REPELLENTS

The natives who inhabit the forests surrounding Manáos are reported to employ two vegetable substances, 'Tocum' and 'Urucu,' to repel the attacks of biting insects. No opportunity occurred of testing the value of 'Tocum.' In regard to 'Urucu,' which Da Matta (1912) states is *Bixa orellana*, the seeds from the shrub of this name are crushed and added to nut oil, the resultant mixture being smeared over the exposed parts of the body. Da Matta (1912) agrees with the native belief that insects will not bite persons so protected. A sample was obtained and rubbed over

one arm, both arms being then thrust into a large mosquito cage, containing hungry *Stegomyia* females. The number of subsequent bites on each arm were as follows :—

Number of bites on arm treated with 'Urucu' 13
Number of bites on untreated arm 15

CONCLUSION. The native preparation known as 'Urucu' is of no value as a repellent of *S. calopus.*

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OBSERVATIONS ON THE RÔLE OF COCKROACHES IN DISEASE

BY

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As the cause of disease and as possible carriers of pathogenic organisms cockroaches have received less attention than other domestic pests, and less than might have been expected considering their wide distribution, their abundance, especially in tropical countries, their filthy habits and the opportunities they have of contaminating food, and the almost universal loathing with which they are regarded.

It is generally admitted that they are eminently fitted to be disseminators of infections, and from time to time they have come under suspicion as such, but hitherto no definite charge appears to have been brought home against them. There is, however, some experimental evidence that certain pathogenic organisms may be transported by them or may pass through their intestines. Morrell (1911), for example, as the result of his experiments, concluded that the insects are able by contamination with their faeces to bring about the souring of milk, to infect food and milk with intestinal bacilli, to transmit the tubercle bacillus, to disseminate pathogenic staphylococci, and to transmit from place to place destructive moulds. Longfellow (1913) showed that they may carry on their legs *Bacillus coli communis*, *B. proteus vulgaris*, *Staphylococcus aureus*, *S. citreus*, and a bacillus of the *subtilis* type, and found the same organisms in their faeces. He, therefore, considered that, as possible carriers of infection, it is almost as important to prevent the multiplication of cockroaches as of house-flies. This view, however, may be somewhat exaggerated, since Herms (1915) has pointed out that the feet of cockroaches are less well provided with spines and hairs than those of the house-fly, and are, therefore, less well adapted to the collection of filth. Barber (1912), working in Manila, has shown that cockroaches may be infected with plague bacilli, and more

recently (1914), that when fed on cultures or samples of human faeces containing cholera vibrios these organisms multiply in their intestines and are discharged in the faeces without losing their virulence. The cockroaches (*P. americana*) themselves are apparently unaffected, and Barber concludes that they may act as carriers of cholera to human food. According to Fibiger (1913), cockroaches (*P. orientalis* and *P. americana*) are also the intermediate hosts of a nematode (*Filaria* sp.) which causes malignant tumours in rats which feed upon them; and Wellman (1910) has suggested that a tapeworm (*Davainea* sp.) may be disseminated by these insects. As supplementing these examples, which are by no means complete, the following notes on a few experiments carried out at Accra may be of interest.

The species of cockroach employed in the experiments was *Periplaneta americana*, L. The insects were kept singly, in wide-mouthed glass jars, which were changed daily, and were fed on moist bread. Before submitting them to any experimental test, their faeces were examined carefully for several consecutive days in order to determine what natural infections they harboured. In the majority of the experiments, the material (faeces, etc.) which it was desired a cockroach should eat was offered to it smeared on bread. As soon as it had been consumed, the cockroach was transferred to a clean, dry jar and fed on moist bread, each pellet of faeces passed subsequently being examined during the following week, or longer period. In some experiments with bacteria, however, when it was necessary to prevent contamination of the limbs, etc., the cockroach was immobilised in a groove in a piece of cork (somewhat resembling a setting-board for lepidoptera) fixed by a layer of paraffin to a glass plate. In this manner the cockroach could be fed at the one end, and its faeces collected at the other without risk of contamination of the faecal pellets by the material used for feeding. The addition of a little carmine to the infecting feed was sometimes found to be of assistance as an indicator showing when the material had passed through the intestine.

The cockroaches usually passed one or two faecal pellets each day, which were either solid or semi-solid. Diarrhoea and the passage of liquid faeces was, however, by no means rare, and the insects were also liable to become constipated under the

conditions of the experiments. When forming their egg-capsules they frequently passed no faeces for several days in succession.

The faeces of the cockroaches always, or almost always contained innumerable bacteria of various types, yeast cells, moulds, fungal hyphae, &c., and in recently captured insects often also a considerable quantity of grit. After being in captivity for some days the number of yeast and fungal cells usually increased, and the bacteria became more numerous. A number of other parasites or coprozoic organisms were noted during the experiments. Perhaps the most common was a ciliate resembling *Balantidium blattarum*, Ghosh, the cysts of which were present in the majority of the cockroaches examined. *Oxyuris blattae* was frequently present, and in a few individuals were found *Entamoeba blattarum*, *Gregarina blattarum*, and a species of spirochaete. Mites,* sometimes still alive, were found in the faeces on a few occasions. Thirty cockroaches were especially examined immediately after capture for eggs of worms known to frequent the intestine of man: in one a single egg indistinguishable from that of *Trichuris trichiura* was found. It should be stated, however, that most of the cockroaches were collected in the laboratory, where they would have little or no opportunity of feeding on human excrement.

TUBERCLE BACILLUS

Morrell (1911) has demonstrated that tubercle bacilli may be found in the faeces of cockroaches which have fed on infected sputum. In confirmation of this observation, three experiments were carried out in collaboration with Dr. A. Ingram and Dr. J. F. Corson.

The cockroaches, whose faeces had been previously examined and found to be free from acid-fast bacilli, were given sputum containing numerous tubercle bacilli from a case of phthisis in an African. They consumed the sputum very readily. Every sample of faeces passed subsequently, some of them fluid or semi-solid, was examined for *B. tuberculosis*, with the following results. The faeces passed on the first day after the infecting feed were free from the bacilli, those passed on the second day to the fourth or fifth day

* These mites have been examined by Mr. S. Hirst, of the British Museum, who has kindly informed me that they are larvae of a Tarsonemid.

contained tubercle bacilli, and after this, up to the fourteenth day, when examinations were stopped, no more tubercle bacilli were detected.

The tubercle bacilli found in the faeces of the cockroaches stained in a normal manner and looked healthy. That they were actually living and virulent was proved by emulsifying one faecal pellet with normal saline solution and inoculating it into the groin of a guinea-pig, which in due course became infected with tuberculosis.

Cockroaches then feed readily on human sputum, and if the sputum contains tubercle bacilli, pass these organisms in their faeces for several days in a living and virulent condition. They do not appear to become infected with the bacilli themselves.

LEPROSY BACILLUS

In two similar experiments, cockroaches were given scrapings from the nose of a leper which contained numerous *B. leprae*. It was found that these bacilli also passed through the intestine of the insects, and appeared in the faeces for a day or two after the infecting feed. So far as could be judged from the appearance of the bacilli and from their staining properties, they had not been injuriously affected.

TYPHOID AND DYSENTERY BACILLI

It has been suggested by Scott (1915) that cockroaches may have acted as mechanical carriers of the infection in an outbreak of typhoid fever in Jamaica, and on other occasions elsewhere these insects have come under suspicion during epidemics of this disease and of bacillary dysentery. Cockroaches might also spread such infections by intestinal contamination. In order to determine if such bacilli, still living, could pass through their intestine, two experiments each were carried out with *Bacillus typhosus*, *B. paratyphosus*, B. and *B. dysenteriae* (Flexner Y).

The cockroaches used in the experiments had been previously tested carefully to see if their faeces contained any organisms resembling bacilli of the typhoid-dysentery group and had been found to be free from such infections. They were immobilised in a groove in a piece of cork with only their heads and tails projecting,

and were fed with small pieces of bread soaked with recent cultures of the bacilli to be tested. Their faeces were tested (in the routine manner) for the bacilli during the following week or ten days, but in none of the six experiments were they recovered.

These experiments, so far as they go, do not support the view that *B. typhosus*, *B. para-typhosus*, B., and *B. dysenteriae* (Flexner Y) can pass unscathed through the intestine of the cockroach, but their number was too small to be conclusive. The faeces of the cockroaches contained a dense and varied bacterial and fungal flora, which may very well have out-grown the more delicate bacilli.

GONORRHOEA

In one experiment Gonococci were fed to a cockroach, and were subsequently sought for in its faeces. None were found either in direct smears or in cultures.

ENTAMOEBA HISTOLYTICA AND *E. COLI*

The cockroaches used in these experiments had previously been carefully examined for amoebic infections, a precaution which was doubly necessary, because some of these insects at Accra had been found naturally infected.

In four experiments cockroaches were given blood and mucous containing numerous actively motile *E. histolytica* from the stools of African patients suffering from acute dysentery. They consumed the samples readily, but neither amoebae nor their cysts were found in their faeces during the following week.

In nine experiments each human faeces containing cysts of *E. histolytica* and *E. coli* were fed to cockroaches. In seven of the former experiments cysts of *E. histolytica* were found in the faeces, and in seven of the latter experiments cysts of *E. coli*. The cysts were observed in the faeces usually for only one to three days, and eventually disappeared completely: they appeared to be healthy and unharmed by their passage through the cockroaches. No amoebae were found.

It would seem, therefore, that cysts of *E. histolytica* and *E. coli* can pass through the intestine of cockroaches without injury, and may thus be disseminated by these insects, but that they do not produce an actual infection in these hosts.

ENTAMOEBA OF A MONKEY

In another experiment entamoebae resembling *E. coli* from the faeces of a monkey (*Cercopithecus patas patas*) were given, but no entamoebae or cysts were subsequently found in the faeces of the cockroach. A few days later the faeces of the same monkey, which now showed numerous eight-nucleated and a few sixteen-nucleated cysts, were fed again to the same cockroach. On the following day no faeces were passed by this cockroach, but on the second and third days its faeces contained numerous cysts, similar to those in the monkey's faeces, which appeared to be healthy and were not stained by eosin. On the fourth day the cysts were fewer, and on subsequent days none were found.

GIARDIA

In two experiments cysts of *Giardia intestinalis* fed to cockroaches in human faeces passed through their intestines apparently unharmed and unchanged.

EGGS OF WORMS

A number of experiments were carried out to determine what was the effect on the eggs of worms of passage through the intestine of cockroaches. The eggs were given in human faeces smeared on bread. The results of the experiments may be summarised as follows.

Hook-worms. Seven experiments. The eggs of *Ancylostoma duodenale* and *Necator americanus* passed through the intestine unharmed, and appeared in the faeces for from one to three days after the infecting feed, the time depending on the rate of passage of the intestinal contents, which was variable. They had undergone some development, many of those found in the cockroaches' faeces containing living embryos, which subsequently hatched when the faeces, with a little saline solution, were mixed with charcoal and kept at the laboratory temperature. It may be added here that other experiments showed that eggs of *Ancylostoma ceylanicum* in dogs' faeces fared similarly when fed to cockroaches.

Ascaris. Five experiments. The eggs of *Ascaris lumbricoides* passed through the intestine and appeared in the faeces of the cockroaches for a day or two. They appeared to be unharmed. In most cases they also were unchanged, but in one experiment, in

which they did not appear in the faeces until the fourth day owing to the fact that the cockroach was constipated, they had undergone slight development, their contents having divided.

Trichuris. Eight experiments. The eggs of *Trichuris trichiura* passed through the intestine with the residue of the infecting feed, and appeared in the faeces apparently unharmed and usually unchanged, but sometimes having undergone slight development, their contents having divided. Eggs were occasionally found also a day or two later, and in this case they were usually empty shells. For example, a cockroach fed with human faeces containing *Trichuris* eggs showed in its faeces on the following day numerous healthy-looking, unsegmented eggs, on the next day a single, healthy-looking, unsegmented egg, on the third and fourth days no eggs, but on the fifth day two empty shells.

Taenia. Four experiments. The eggs of *Taenia saginata* used appeared in the faeces of the cockroaches apparently unchanged in two of the experiments, in one only shruken eggs were observed, and in the fourth none were found. The eggs were scanty in the sample of human faeces used in these experiments.

Bilharzia. No opportunity has occurred of experimenting with the eggs of *Schistosoma mansoni.* In one experiment, however, urinary deposit containing numerous eggs of *S. haematobium* was fed to a cockroach on bread. The eggs, apparently unchanged, appeared in the faeces of the insect on the following day.

From these experiments it is clear that the eggs of many intestinal worms may pass unharmed through cockroaches, and as these insects readily feed on human faeces they may aid in the dissemination of these parasites. In some cases the initial stages of development took place in the eggs during their sojourn in the cockroaches.

APHIOCHAETA XANTHINA

The larvae of the small fly *Aphiochaeta xanthina,* Speiser, which belongs to the Family *Phoridae,* are known to cause intestinal myiasis in man in the Gold Coast, it being supposed (Patton, 1922) that 'its eggs and larvae probably gain entrance to the human alimentary tract in food, and particularly in stale meat.' In a single experiment eggs of this fly were given to a cockroach on moist

bread, and were eaten by it. On the second and third days following the experimental feeding the faecal pellets passed by the cockroach were found to contain fragments of the eggs and one or two almost complete eggs which appeared to be empty. Thereafter, up to the fourteenth day, when examinations were discontinued, no evidence was found of the presence of the fly in any stage of its development.

SUMMARY

The following organisms appeared to pass unharmed through the intestine of the cockroach *Periplaneta americana*:—*Bacillus tuberculosis*, *B. leprae*, cysts of *Entamoeba histolytica*, *E. coli* and of an entamoeba of a monkey resembling *E. coli*, cysts of *Giardia intestinalis*, and eggs of *Ancylostoma duodenale*, *A. ceylanicum*, *Necator americanus*, *Ascaris lumbricoides*, *Trichuris trichiura*, *Taenia saginata*, and *Schistosoma haematobium*.

On the other hand Gonococci, *Entamoeba histolytica*, *E. coli*, and an entamoeba of a monkey resembling *E. coli* (in the vegetative stages), eggs of *Aphiochaeta xanthina*, and, in two experiments each, *Bacillus typhosus*, *B. para-typhosus*, B., and *B. dysenteriae* (Flexner Y) were not recovered in the faeces of cockroaches after experimental feeding.

No evidence was obtained that any of the organisms used in the experiments established themselves as parasites in the intestine of the cockroaches.

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THE OCCURRENCE OF *XENOPSYLLA ASTIA*, ROTHS., IN WEST AFRICA

BY

A. M. EVANS

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Collections of rat fleas made at Accra, Gold Coast, during the months August, 1921, to July, 1922, inclusive, have been received for identification from Dr. A. Ingram.

Among the April and May samples were specimens of *Xenopsylla astia*, Roths. This species has not, as far as I am aware, been found hitherto in Africa: it is, therefore, thought desirable to place its occurrence at Accra on record.

The data are as follows:—

From *Mus decumanus*, April, 1922, *X. astia*, ♂♂ 9; ♀♀ 13.
From *Cricetomys gambianus*, April, 1922, *X. astia* ♀ 1; May, 1922, ♂ 1; ♀ 1.

NOTES ON A CASE OF BLACKWATER FEVER

BY

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(Received for publication 27 November, 1922)

The writing of this note has been prompted by some remarks of Professor Warrington Yorke (1922) in a critical review of recent work on the pathology of blackwater fever. These will be referred to later.

CLINICAL HISTORY

J. D. T., aged 28, suffered from no disease of importance until June, 1921, when he contracted malaria in West Africa. This was a slight attack. In February, 1922, he had a severe attack of malaria, with which he was invalided home. He arrived in England on March 20th, and remained comparatively well, taking a small dose of quinine daily, till April 10th. On that day he felt shivery, and went to bed after mid-day. In the evening he took 15 grains of quinine. Next morning (April 11th) he still felt out of sorts, and at 11 a.m. passed dark red urine. Similar urine was passed at 1 p.m. I saw him in the early evening of the same day, and he was admitted to Professor T. K. Monro's wards in the Western Infirmary of Glasgow a couple of hours later. He looked rather ill, with temperature 102·6°, headache, and some yellowness of the skin. The spleen was enlarged, and the blood-film showed a few subtertian malarial parasites. A condition of suppression of urine had apparently set in, for, though he had passed no urine for eight hours, there was no desire to micturate, and the bladder was not distended. A few cubic centimetres of blood were taken for examination, and then 1,800 c.c. of 1 per cent. saline was injected intravenously. This injection, together with three litres of fluid taken by the mouth during the night had the effect of re-establishing

the flow of urine, and within twelve hours he passed 2,200 c.c., coloured dark red. Throughout the rest of the illness the output of urine was good, the lowest recorded in any twenty-four hours being 1,100 c.c. (April 28th). Haemoglobinuria continued for four days, but by April 15th there was no reaction with guaiac. The patient, however, was becoming increasingly ill, and for two days (April 15th-17th) it looked as though he were going to die. He was delirious, anaemia was intense (Hb. 16 per cent. on April 16th), and there was remittent pyrexia which continued to range from 99° to 103° or 104° until April 18th. Thereafter the temperature did not exceed 100° except for twenty-four hours on April 21st-22nd, when it reached 102·4°. This coincided with a recurrence of haemoglobinuria for a similar period. It became normal on April 25th, and remained so during convalescence except for a rise on May 6th-8th from a relapse of malaria, during which a few subtertian rings were again found in the blood. He was dismissed hospital well on June 2nd.

Urine

The state of the urine is here shown :—

Date		Colour	Specific gravity	Guaiac test
April	11 ...	dark red	1018	+
„	12 ...	„	1015	+
„	13 ...	dark amber	1020	+
„	14 ...	amber	1020	–
„	15-20 ...	„	...	–
„	21 ...	dark amber	1022	+
„	22 ...	dark red	1025	+
„	23 onwards	amber		–

The specimens of red urine had a copious brownish deposit, which showed brown casts under the microscope. No red corpuscles were seen, Spectroscopic examination showed the bands of oxy-haemoglobin.

Blood

The specimen of blood taken on admission to hospital was run into a dry tube and was allowed to clot. The serum which separated was dark red in colour. It was not matched with a standard, but was much darker than the tube of a Gowers'

haemoglobinometer. The spectrum was that of oxy-haemoglobin. The urea in this sample of serum was estimated, and was found to amount to 84 mgm. per 100 c.c. of blood. The method employed for the estimation was that described by Kennaway (1920), which depends on the power of an enzyme in the soya bean to break up urea quantitatively into ammonium carbonate, and briefly is as follows. The serum is treated with alcohol to remove the protein, and then is diluted with water. A few drops of a methyl red solution are added as an indicator, and the fluid is brought to a buff shade which corresponds to a constant acidity. A control flask containing water is brought to the same shade, that is, to the same reaction, and to each is added a watery extract of powdered soya bean. The flasks are incubated in a water-bath for an hour, and then by titration the difference in the acidities is ascertained. This difference is due to the production of ammonium carbonate in the serum, and the degree of alkalinity produced indicates the amount of urea originally present. Full details of the method will be found in the original paper. Normal blood gives a reading of 30 to 35 mgm. of urea per 100 c.c.

A few blood-counts were done:—

Date		Hb %	Red Cells	Leucocytes
April 16	...	16	1·3 m.	14,000
„ 26	...	30	1·9 m.	11,000
May 7	...	52	3·5 m.	...
„ 15	...	60	3·8 m.	...
„ 21	...	76	4·2 m.	...

m = million.

A film taken when the anaemia was severe (April 17th) showed marked anisocytosis of red cells, with some megalocytes. Nucleated reds numbered five hundred per c.mm. A differential leucocyte count showed neutrophil polymorphs 77 per cent., lymphocytes 18 per cent., large hyalines 2 per cent., eosinophil polymorphs 3 per cent. Immature polymorphs were numerous. By May 21st the blood-film was practically normal.

Examination of thick films for malarial parasites showed:—

On April 11	...	A few subtertian rings
„ 13	...	No parasites
„ 15	...	„ „
May 6	...	A few subtertian rings
„ 21	...	No parasites

Quinine

The following doses of quinine sulphate were given by the mouth:—

April 17	...	gr. 3
„ 18, 19	...	gr. 6 daily
May 6, 7	...	gr. 5 daily
„ 8 onwards		gr. 10 daily

REMARKS

A point of interest in this case is the occurrence of marked haemoglobinaemia on the day on which haemoglobinuria began. In the review referred to, in the first paragraph, Yorke writes: 'There is unfortunately astonishingly little in the way of precise information on this important point' [the presence of haemoglobinaemia], and he quotes from Christophers and Bentley: 'Examination of the blood in blackwater fever has shown without exception the presence of true haemoglobinaemia, demonstrated by the centrifuging of blood received into hypertonic citrate solution; the serum after clotting has also always shown haemoglobin . . . but in both cases the amount was usually small, and more or less masked by the extraordinarily intense yellow coloration of the serum.' In the case I have described the serum was dark red.

Yorke raises the question also as to whether Plehn is correct in stating that the urine in blackwater fever is of extraordinarily low specific gravity, and mentions numerous instances in favour of the opposite view. In the case of J. D. T., the four 24-hours' specimens of red urine showed a specific gravity of 1018, 1015, 1020, and 1025.

A further point of interest is the rise in the blood urea at the end of a quite short period of suppression of urine.

As regards treatment, it seems to me that in this case the injection of saline intravenously when failure of urinary secretion showed itself had much to do with the re-establishment of the flow. I have made this observation before (1918).

As has been pointed out to me by Professor C. H. Browning, there is a striking difference between the symptomatology of blackwater fever and that of paroxysmal haemoglobinuria. In the latter condition the patient may be disturbed hardly at all by an attack of haemoglobinuria, whereas in the former the disturbance is

profound. In the case I have described, it was noticeable that not only did the patient not improve with the cessation of haemoglobinuria, but he grew worse for two days, with continuation of the pyrexia, and for four days at least after the urine had become clear his condition was critical.

SUMMARY

A case of blackwater fever is described in which haemoglobinaemia was marked. The blood urea was found to be much increased after a short period of anuria.

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CASE OF TRYPANOSOMIASIS

BY

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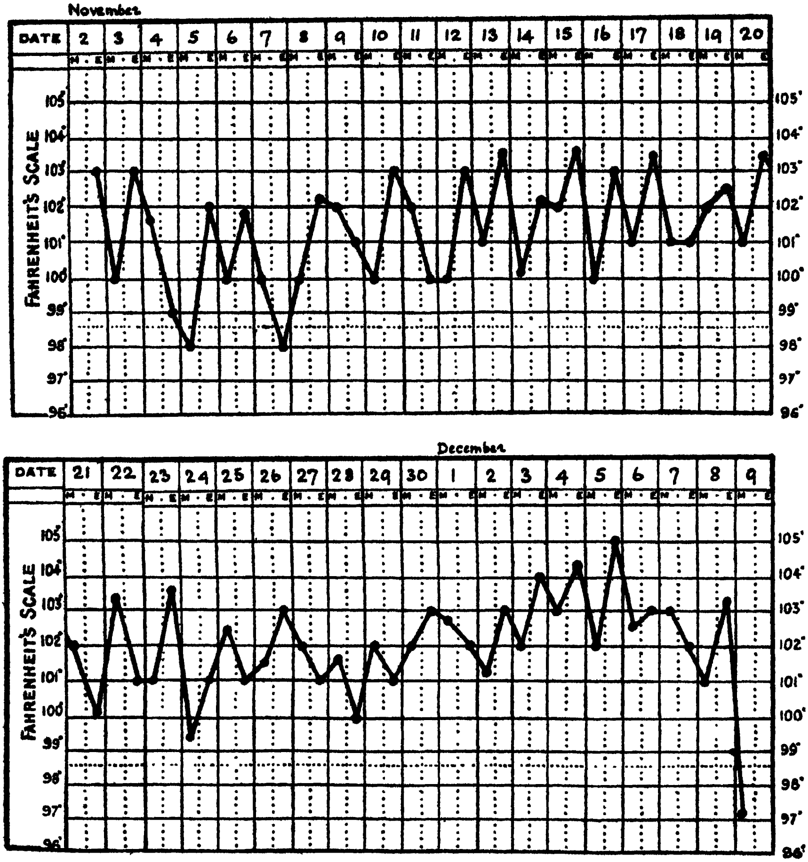
RHODESIAN MEDICAL SERVICE

(Received for publication 27 November, 1922)

The following notes are published, as the case was one of interest.

The patient, a married European woman about 18 years of age, had, in August, 1919, accompanied her husband on a shooting expedition in a tsetse-fly area in Sebungwe, S. Rhodesia. After she had been on the veldt six or seven weeks she became ill, and was taken to the nearest town and treated for malaria for three weeks. As at the end of this time her condition had not improved, she decided to return to her own home. On admission to hospital on October 31st she was evidently acutely ill, and had a temperature of 102°. She complained of intense headache and severe pain all over the body. The spleen was slightly enlarged, and the posterior cervical glands were also slightly enlarged and tender on pressure. A blood smear taken on admission and stained with Giemsa showed a very severe trypanosome infection. The trypanosome appeared to be *T. brucei* vel *rhodesiense*. Posterior nuclear forms were found in the patient's blood. This diagnosis was confirmed by intraperitoneal inoculation of the patient's blood into a rabbit. Treatment with galyl, soamin and tartar emetic had no effect, and the patient gradually became worse. Hyperaesthesia was a marked feature of the case from the outset. The slightest touch made her cry out with pain. Her mentality changed, and she became childish and played with dolls. About the middle of November she developed keratitis, which affected both eyes. This became worse, and in a fortnight she was almost completely blind. Emaciation was progressive throughout the illness. She gradually sank, and became comatose two days before her death, which occurred on December 9th.



Case of Trypanosomiasis: Chart.

OBSERVATIONS ON *ONCHOCERCA VOLVULUS*

BY

J. W. S. MACFIE

AND

J. F. CORSON

(*Received for publication* 28 *November*, 1922)

The following brief and somewhat disconnected notes on *Onchocerca volvulus* are based on observations made at Accra in the Gold Coast, West Africa.

DIAGNOSIS. The tumours of *O. volvulus* are by no means always large and easily recognisable, but are frequently very small, deep-seated, and difficult to detect. In some cases, indeed, we have been able to palpate them only after they had been located for us by the patients themselves. The diagnosis of volvulosis by the presence of tumours is, therefore, unreliable, and we have found it more satisfactory to examine the skin for larvae.

The method we adopt is to remove from the lower part of the back a small piece of skin similar to, but rather larger than, those used in skin-grafting by Reverdin's method. The skin is raised with the point of a needle, and a piece of the required size snipped off with a pair of sharp scissors. The pieces of skin may be examined immediately by teasing them on a slide with a little normal saline solution, or they may be left for an hour or two in saline solution in small tubes, in which case the larvae will be found to have worked their way out and to be lying at the bottom, or they may be used for sectioning. The technique is simple and rapid, and as it is not painful and is not objected to by African patients, is capable of wide application. The little wounds heal rapidly.

In such pieces of skin removed from patients with *O. volvulus* tumours we have invariably found larvae. In the one or two apparent exceptions met with, the tumours on removal proved to be juxta-articular nodules, and not *O. volvulus* tumours. In many other cases in which no tumours could be found, the pieces of skin removed in this way contained *O. volvulus* larvae.

As regards 'lichenification' and the other skin conditions

sometimes considered to be due to volvulosis, we have on the one hand observed them in skin in which no larvae were found, and on the other hand found larvae abundantly present in apparently normal skin. Moreover, we have recently found another filarial larva in the skin which, at Accra at any rate, is even more commonly present than that of *O. volvulus*. In view of this discovery, further observations are necessary before it can be said if either of the two larvae is responsible for the lesions.

INCIDENCE. In order to obtain some idea of the prevalence of *O. volvulus* infection in the Gold Coast, fifty men, taken at random, were examined at Accra, all of whom were adults, between the ages of 25 and 45 years, who appeared to be in good health. The examinations were made on the 24th of October, 1922, between the hours of 9.45 and 10.15 a.m.

From each man a small piece of skin, as described above, was removed from the small of the back and placed in a tube containing about 2 c.c. of normal saline solution. The piece of skin was subsequently teased up together with a drop or two of the saline solution from the bottom of the tube, the preparation fixed by heating, dried, and stained with haemalum. In no case was there obvious blood in the specimen.

The result of this examination was that larvae of *O. volvulus* were found in seventeen of the men (equal to 34 per cent.).

PERIODICITY. Ten of the men referred to above, in whom larvae had been found, were re-examined two days later at about 9 p.m. No sensible difference was observed suggestive of a periodicity in the prevalence of the larvae in the skin. This observation is in harmony with that of Montpellier and Lacroix (1920).

DISTRIBUTION OF THE LARVAE IN THE BODY. In most of the cases examined we have sought for the larvae of *O. volvulus* in the skin of the lumbar region or the small of the back only. In a few instances, however, we examined other parts also; for example, in a Kru man with a small tumour in the left inguinal region, larvae were found abundantly in the skin of the left buttock, the right ankle, the right shoulder cap, and the right wrist. Our observations, indeed, showed clearly that even in subjects in whom no tumours could be detected and whose skin was normal, larvae of *O. volvulus* might be found in the skin of widely separated regions of the body.

TABLE

The distribution of *O. volvulus* larvae in the body.

Parts of the body examined	I Kru man, c. 25	II Ashanti man, c. 40	III Ashanti man. c. 40
Skin of scalp : left occipital region ...	nil	—	—
above the right ear ...	—	—	nil
Skin, behind the left ear	—	*mf. v.* numerous	—
Skin : right wrist	—	—	nil
left wrist	*mf. v.* numerous	—	—
Skin, second finger of right hand ...	—	nil	—
Skin, small of back	*mf. v.* numerous	*mf. v.* few	*mf. v.* numerous
Skin, scrotum	—	—	*mf. v.* few
Skin : right ankle	*mf. v.* numerous	*mf. v.* numerous	—
left ankle	—	—	*mf. v.* numerous
Mucous membrane of mouth, lower lip...	nil	nil	nil
Stomach	nil	nil	—
Small intestine	nil	nil	—
Large intestine	nil	nil	—
Rectum	—	—	nil
Mesentery	nil	nil	nil
Parietal pleura, 8th interspace	nil	nil	—
Intercostal muscle, 8th interspace ...	nil	—	—
Lung	nil	nil	nil
Heart, left ventricle	nil	nil	—
Aorta	nil	nil	nil
Peritoneum...	nil	nil	—
Liver	nil	nil	nil
Spleen	nil	nil	nil
Kidney	nil	nil	—
Bladder	nil	nil	—
Brain : cerebral cortex	—	—	nil
cerebellum	—	—	nil
Lymphatic glands : near aorta	nil	—	nil
mesenteric... ...	nil	nil	nil
inguinal	nil	—	nil

mf. v. = larvae of *Onchocerca volvulus*.
nil = no larvae found.
— = not examined.

In order to ascertain more accurately the distribution of the larvae in the body, three natives were examined particularly in the mortuary, the first a Kru man, aged about 25 years, and the second and third Ashanti men, aged about 40 years. The first two men had died from pulmonary tuberculosis, and the third from cerebral congestion. No tumours were found in any of the three, and no definite skin lesions of the types associated with volvulosis, excepting in the third man, who had slight 'lichenification' of the back.

The various parts of the body examined, and the results, are shown in the accompanying table. About 0·25 c.c. of each tissue was examined. It will be noted that larvae were found in the skin of widely separated areas, but that they were not found in any of the mucous membranes or organs.

During the autopsies a careful search for adult worms was made in the mesentery and the retro-peritoneal tissue in the neighbourhood of the liver, the duodenum, and the aorta, but none were found. The inner surface of the aorta (in view of the fact that *O. armillata* is abundant in this situation in cattle at Accra), and a number of lymphatic glands from the mesentery, the inguinal region, and near the aorta were also examined without success.

LARVAE ARE NOT FOUND IN SWEAT. Although the larvae of *O. volvulus* are abundant in the skin, they do not appear in the sweat. One of the laboratory staff, a Mendi, in whose skin larvae were numerous, was set to work in the sun until he perspired freely. Sweat was then collected from his face, chest, abdomen and back, and examined for larvae. None were found.

EXPERIMENTS WITH TSETSE-FLIES. Leiper (1913) failed to trace any development of the larvae of *O. volvulus* in *Stemoxys calcitrans* and *S. nigra*, and Rodhain and Van den Branden (1916) failed with *Stegomyia fasciata* and *Cimex rotundatus*. Brumpt has suggested that the larvae may develop in a tsetse-fly, but so far as we are aware, no observations have yet been recorded in support or otherwise of this view. A few experiments were, therefore, carried out at Accra, in which wild tsetse-flies were fed on patients in whose skin *O. volvulus* larvae were abundant, and subsequently dissected and examined for developmental stages of these parasites. Unfortunately for our purpose Accra is situated in an extensive

tsetse-free area, and we were, therefore, able to procure only a few living flies for our experiments.

Glossina palpalis, R. D. Three flies were fed once only on a case of volvulosis and dissected, two on the sixth day, and one on the seventh day after the infecting feed. No filarial larvae were found. Ten specimens which had not been fed experimentally were also dissected as a control. No filarial larvae were found in them.

G. longipalpis, Wied. Six flies were fed once only on a case of volvulosis and dissected, two on the twelfth day, and one each on the second, fourth, fifth and sixteenth days after the infecting feed. No filarial larvae were found. Fifteen specimens which had not been fed experimentally were also dissected as a control. No filarial larvae were found in them.

These few observations do not support Brumpt's suggestion, so far, at any rate, as concerns *G. palpalis* and *G. longipalpis*. The number of flies employed was, indeed, regrettably small, but if volvulosis is as prevalent as the figures we have given suggest, and if the parasites are able to develop in them, it might have been expected that one or two of these tsetse-flies (including the controls) might have shown them.

EXPERIMENTS WITH LICE. From the usual position of the larvae in the skin, namely, close under the rete mucosum, we are inclined to think that the intermediate host, if indeed it is a biting insect, will prove to be one which does not probe the skin deeply. Lice at once suggest themselves, but so far as our observations have at present proceeded we are not able to incriminate them. One of us (J. F. C.) dissected about sixty specimens of *Pediculus humanus corporis* at Sekondi without finding any filarial larvae, and further dissections (forty-six) at Accra have been equally fruitless. Moreover, twenty lice taken from the bodies of two men not infected with *O. volvulus* and fed on a man who harboured larvae of *O. volvulus* in his skin, and larvae of *Acanthocheilonema perstans* in his blood, were dissected an hour later. Larvae of *O. volvulus* were not found in any of them, but living and active larvae of *Ac. perstans* were observed in eight. This experiment suggests that the lice, in feeding, draw up the larvae present in the blood of their host, but not those in his skin. It may be added that in several of the lice dead and partly digested larvae of *Ac. perstans* were found

(derived, presumably, from some previous host), an observation which confirms that of Low (1903), who failed to trace development of this worm in *P. capitis* and *P. vestimentorum*.

From the fact that the larvae are particularly numerous in the skin at the base of the trunk (buttocks, scrotum, &c.), *Phthirius pubis* might be regarded as a likely host. Contrary to expectation, these creatures have proved difficult to obtain at Accra, and we have not yet been able to procure any for dissection and experiment.

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A NEW SPECIES OF FILARIAL LARVA FOUND IN THE SKIN OF NATIVES IN THE GOLD COAST

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When investigating the occurrence of larvae of *Onchocerca volvulus* in the skin of natives in the Gold Coast, sheathless larvae of another species of Filariidae were found in several cases. So far as we are able to ascertain these larvae have not previously been noted, and, therefore, notwithstanding the fact that we have not yet discovered the adults, a brief description of them is given here.

The larvae were found in the skin of nine out of twenty-four cases selected for examination for *O. volvulus* larvae either because they had tumours, or because the skin showed the conditions which have been associated with that infection. From each of these cases a piece of skin, about half a square centimeter, was removed from the small of the back and placed in a tube containing normal saline solution. The larvae, which were found in the deposit which collected at the bottom of the tubes, were fixed by adding Ruge's solution to some of the deposit on a slide, allowed to dry, and subsequently stained with haemalum. The larvae were also found in the skin of the forearm and back in one out of nine unselected autopsies. In this case the larvae were fixed on a slide by heating, dried, and stained with eosin-azur.

The description of the larva which follows is based on the examination of specimens from these ten cases. Seventy-two larvae were measured, ten from each case in which this number could be found, and all that were available in the others. It may be noted here that there was a certain degree of variation in the size of the larvae in different cases, in some they were on the average slightly larger than in others.

MORPHOLOGY. The larvae are sheathless, slender, tapering both anteriorly and posteriorly, and when fixed assume a characteristic form, the body being straight, or nearly so, excepting at the posterior extremity, which is curved round like the handle of a walking-stick (see fig. 1, A). The cuticle is striated. The nuclei are

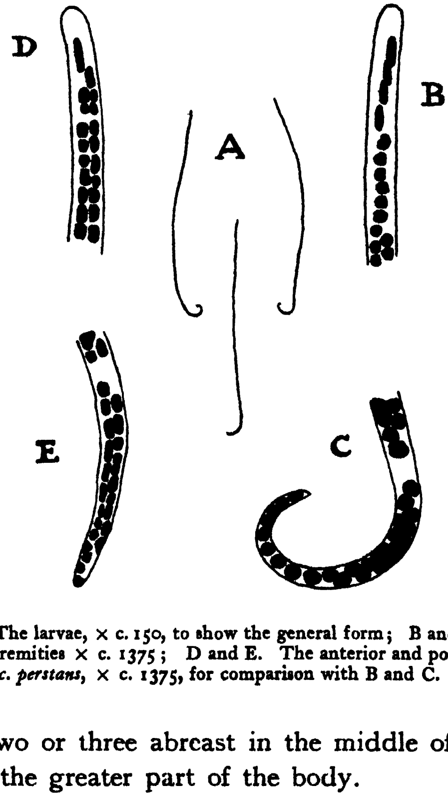

FIG. 1.—A. The larvae, × c. 150, to show the general form; B and C. The anterior and posterior extremities × c. 1375; D and E. The anterior and posterior extremities of the larva of *Ac. perstans*, × c. 1375, for comparison with B and C.

rather large, two or three abreast in the middle of the larva, and completely fill the greater part of the body.

Length. The lengths of the seventy-two larvae measured ranged from 180μ to 240μ, average 215·5μ. The table shows that nearly 60 per cent. were between 210μ and 229μ.

Breadth. The breadth at the widest part of the body is about 3μ.

Anterior extremity. The body tapers very slightly towards the anterior extremity, and is bluntly rounded at its end. No 'fang' could be distinguished. The clear area at the anterior end is about 4μ long. The column of nuclei commences with a single row of ten

or twelve nuclei, the first four being usually oval and the others somewhat quadrate.

The distribution according to lengths, and to the position of the nerve ring, of seventy-two of the filarial larvae.

Lengths, in microns		Nerve Ring: distance from anterior extremity, in microns.	
180μ to 189μ	5	40μ to 44μ	—
190μ to 199μ	6	45μ to 49μ	2
200μ to 209μ	7	50μ to 54μ	17
210μ to 219μ	22	55μ to 59μ	28
220μ to 229μ	21	60μ to 64μ	22
230μ to 239μ	10	65μ to 69μ	2
240μ to 249μ	1	70μ to 74μ	1

Other anatomical fixed points. The nerve ring is situated about 26·9 per cent. of the length from the anterior extremity: it is a well marked break, in the middle of which is a single, prominent nucleus. In the seventy-two individuals measured, its position varied from 48μ to 71μ, average 58μ from the anterior extremity. The excretory pore is small, and is situated about 34·1 per cent. of the length from the anterior extremity; the excretory cell lies slightly more posteriorly. The G 1 cell, which is not always easily recognised, is large, with a round nucleus, and situated about 69·2 per cent. of the length from the anterior extremity. The anal pore is a small break in the column of nuclei situated about 86·2 per cent. of the length from the anterior extremity. A central viscus was not seen.

Posterior extremity. The body tapers for a considerable distance towards the posterior extremity, and the extreme tip of the tail, beyond the last nucleus, is abruptly pointed so that the posterior clear area is at most about 1μ long. The tail is curved sharply into a crook, and the column of nuclei at its extremity is a single row of rounded, or at most oval, nuclei.

SITES WHERE THE LARVAE WERE FOUND. The larvae were found only in the skin. The part examined in nine of the cases was the

small of the back, and in one case the right forearm and the back between the blades of the scapulae. In the latter case skin from the abdomen near the umbilicus and from the middle of the outer side of the calf of the left leg were also examined, but no larvae were found in these situations. In nine cases six or more blood films from the finger and from the back (near to the spot where larvae were found in the skin) were examined; and in two of these four thick films taken at night, and in two others 3 c.c. of blood taken during the day, were also examined. In none of these specimens were the larvae found. Larvae of *Acanthocheilonema perstans*, however, were found in two.

In one post-mortem examination in which the larvae were found in the skin of the small of the back, the following parts of the body were also examined, but without discovering any larvae: skin of scalp above the right ear, skin of right wrist, skin of left ankle, skin of scrotum, mucous membrane of the mouth, rectum, lung, aorta, liver, spleen, cerebral cortex of brain, cerebellum, and lymphatic glands along the aorta, in the mesentery, and in the right inguinal region.

Sections of the skin showed the larvae lying in the tissue spaces of the cutis vera or corium, usually close to the rete mucosum. There was present in all the cases examined a slight degree of cellular infiltration, especially round the blood vessels, but with this exception no definite departure from the normal condition was observed.

PATHOGENICITY. Our observations, which were made in the course of an investigation of volvulosis, do not admit of any statement being made as to the effects which may be caused by infection with this parasite. It may be noted, however, that the condition of the skin known as 'lichenification' was present in six of the ten cases examined, and a definite thickening in two others. Larvae of *O. volvulus* were present in the skin of five cases, but were absent from four of the six which showed 'lichenification.' It is, therefore, possible that the presence of the larvae in the skin may cause irritation and lead to pathological changes.

INCIDENCE. In order to gain some idea of the prevalence of this filarial infection in the Gold Coast, fifty men, taken at random, were examined at Accra. All the subjects were adults between the

ages of 25 and 45 years, who appeared to be in good health. The examinations were made between 9.45 and 10.15 a.m. on the 24th of October, 1922.

From each man a small piece of skin, similar to those taken for skin-grafting by Reverdin's method, was removed from the small of the back and placed in a tube containing about 2 c.c. of normal saline solution. The piece of skin was subsequently teased up

Fig 2 —Photo-micrograph of section of skin to show the position of the larvae.

together with a drop or two of the saline solution from the bottom of the tube, the preparation fixed by heating, dried, and stained with haemalum. In no case was there obvious blood in the specimen.

The result of this examination was that filarial larvae of the species here described were found in twenty-two of the men (equal to 44 per cent.). It may be noted, moreover, that larvae of

O. volvulus were found in seventeen (equal to 34 per cent.), and that in eight of these cases the other larva was also present.

PERIODICITY. Ten of the men referred to above, in whom the larvae had been found, were re-examined two days later at about 9 p.m. No sensible difference suggesting periodicity in the prevalence of the larvae in the skin was observed.

DIAGNOSIS. The larva may be distinguished at a glance from that of *O. volvulus*, which also occurs commonly in the skin, by its slender body, crook-shaped posterior extremity, and blunt tail. In some respects it resembles the larva of *Filaria demarquayi*, but, apart from the fact that it apparently does not occur in the blood, it differs in that the tail is blunt, not sharply pointed, and that the column of nuclei extends practically to the tip of the tail.

The larva from which it has to be distinguished most carefully is that of *Ac. perstans*, which also is sheathless and striated and has a stumpy tail to the tip of which the column of nuclei extends, and which occurs in the blood, but may also be found in small pieces of skin removed in the manner described. The descriptions of the larva of *Ac. perstans* which we have been able to find are somewhat meagre, and do not agree in every respect. For example, Stephens (1916) gives the following measurements, length 160μ to 210μ, breadth 5μ to 6μ, nerve ring 34μ, excretory pore 49μ, genital pore 125μ, and notes that smaller larvae occur measuring 90μ to 110μ by 4μ; Rousseau (1919) gives, length 145μ to 185μ, breadth $3{\cdot}5\mu$ to 5μ, nerve ring 25 per cent., excretory pore 32 per cent., G 1 cell 60 per cent., and anal pore 84 per cent.; and Johnston (1914) gives, length 83μ to 170μ, nerve ring 23·2 per cent., excretory pore 32·9 per cent., G 1 cell 62·6 per cent., and anal pore 83·5 per cent.

In order to obtain comparable data, twenty larvae of *Ac. perstans*, fixed and stained in the same manner as the other larvae, were measured by us. In these specimens the length varied from 158μ to 214μ, average $179{\cdot}4\mu$, breadth $2{\cdot}5\mu$ to 5μ, and the approximate positions of the nerve ring, excretory pore, G 1 cell, and anal pore in a larva of the average length ($179{\cdot}4\mu$) were respectively 22·5, 32·7, 62·3, and 81·1 per cent. of the length from the anterior extremity.

The larva of *Ac. perstans* is, therefore, shorter than the larva described in this paper, relatively stouter, and the nerve ring, the

G 1 cell, and the anal pore are situated more anteriorly. When fixed in the manner described, it is, moreover, straight and not crook-shaped at its posterior extremity, and the column of nuclei at the anterior end is not reduced to a row of ten to twelve nuclei in single file.

For the new parasite we propose the name *Agamofilaria streptocerca*.

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